ARMY ORDNANCE

VOL. XXVII, No. 145 JULY-AUGUST, 1944

Armament and World History
Maj. Gen. J. F. C. Fuller

Pattern for Victory
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Safety in Explosives Plants
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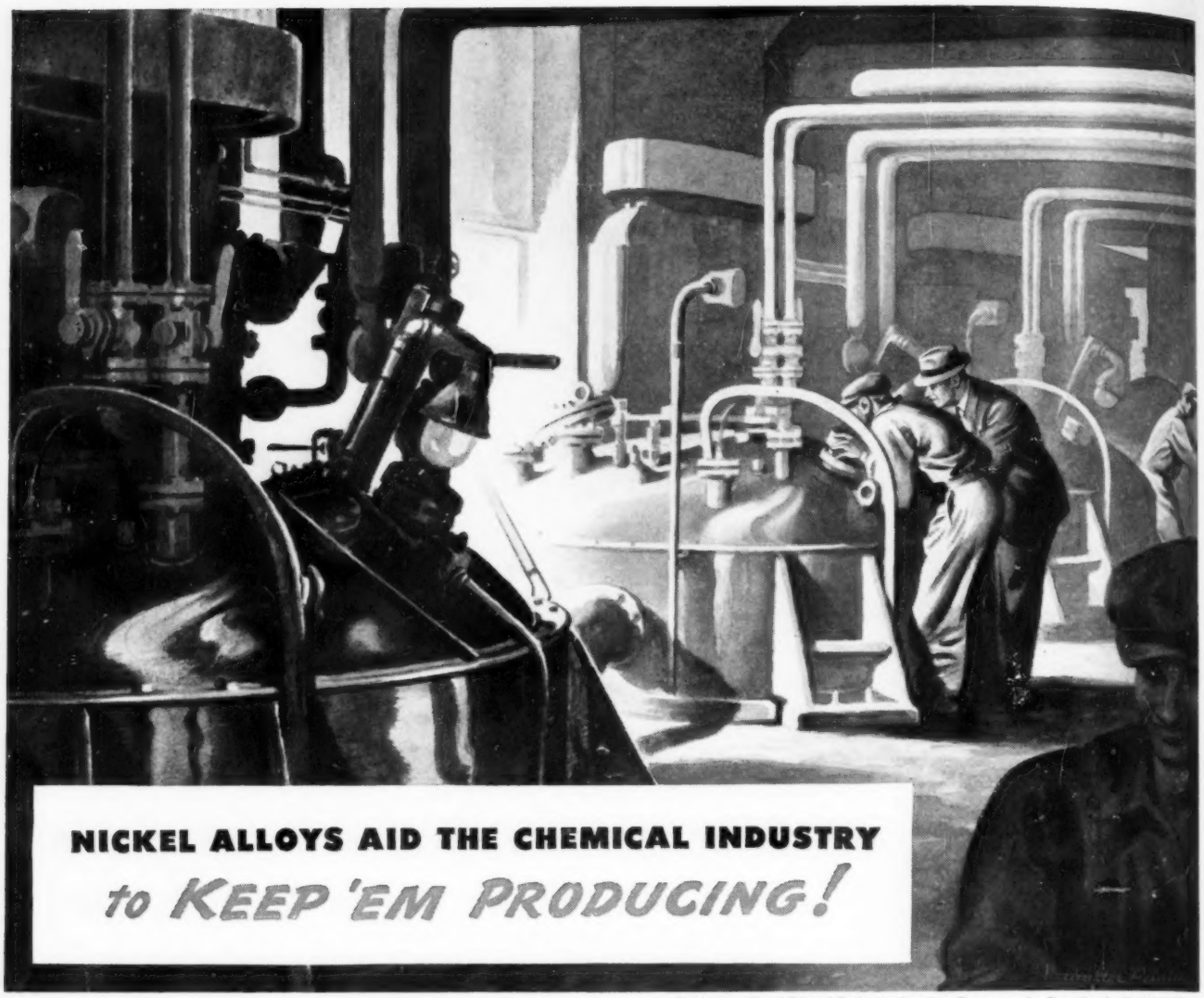
Col. G. K. Heiss

Economy in Weapon Production
Maj. A. R. Coleman

Japanese Small Arms
Capt. Melvin M. Johnson, Jr., U.S.M.C.R.

A REVIEW OF INDUSTRIAL PREPAREDNESS FOR NATIONAL DEFENSE
PUBLISHED BY THE ARMY ORDNANCE ASSOCIATION, WASHINGTON, D. C.



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ARMY ORDNANCE

THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

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For Victory through Armament Research, Production, and Supply

Volume XXVII JULY-AUGUST, 1944 **No. 145**

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The Association has endeavored during the past twenty-five years to keep alive an interest in and knowledge of the design, production, and maintenance of military armament. This it has done through periods of public lassitude and times of great national emergency. Until 1940 there was no peacetime armament industry in the United States for the production of ordnance. Now all American industry is geared for victorious war production.

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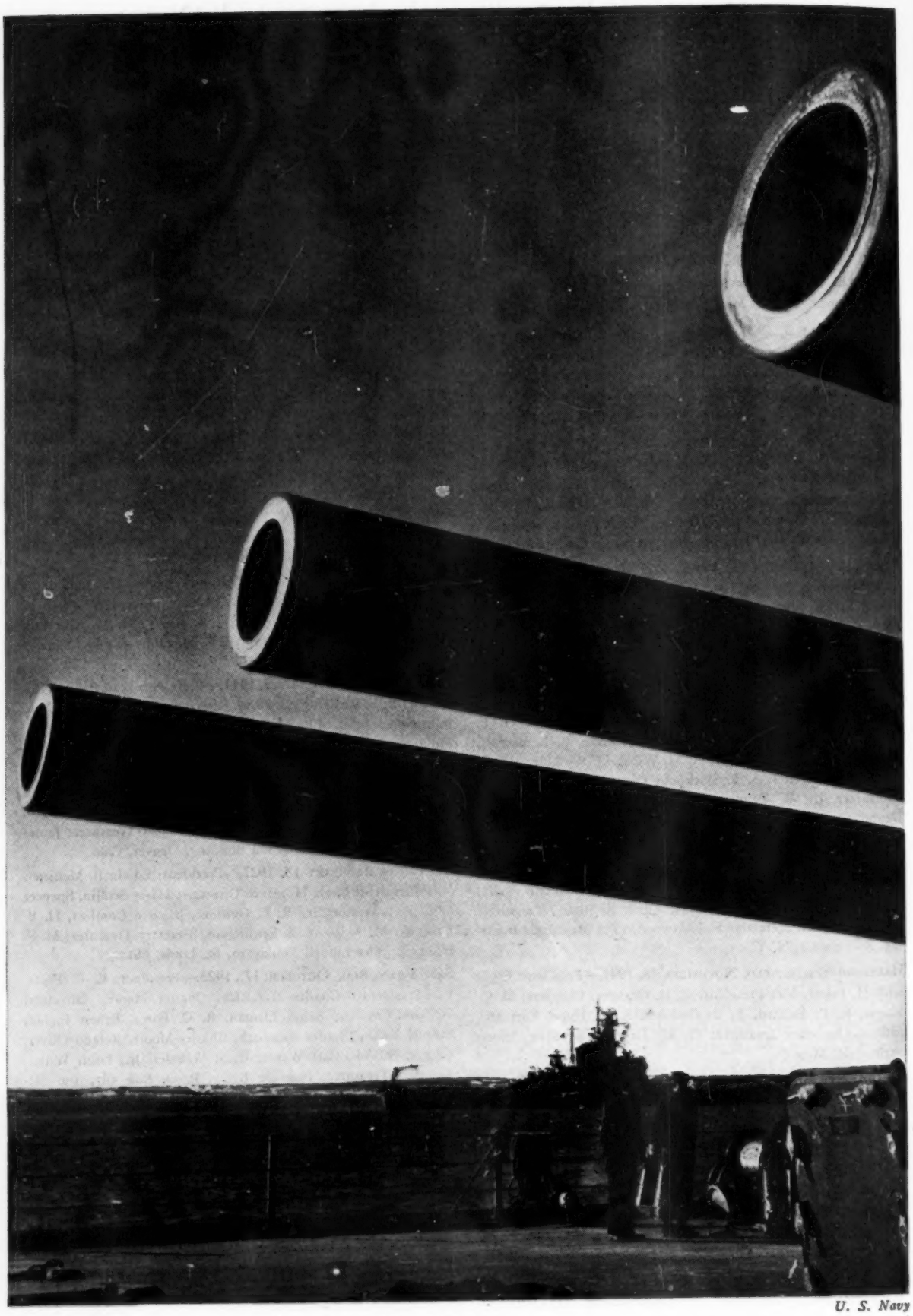

U. S. Navy

Naval Ordnance

ARMY ORDNANCE

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Armament and World History

The Development of Weapons in the Course of Civilization—I

Maj. Gen. J. F. C. Fuller

"WAR in its literal meaning," wrote Clausewitz, "is fighting. . . The necessity of fighting very soon led men to special inventions to turn the advantage in it in their own favor. In consequence of these, the mode of fighting has undergone great alterations; but in whatever way it is conducted its conception remains unaltered, and fighting is that which constitutes war. . . Fighting has determined everything appertaining to arms and equipment, and these in turn modify the mode of fighting; there is, therefore, a reciprocity of action between the two."[1]

Herein is included the whole technique of war: on the one hand the instruments and on the other their use. Instruments include weapons and their organizations; their use embraces operations and policies. On this question Quincy Wright defines the technique of war as "the art of preparing military instruments for mastering, with the least cost, all possible enemies and of utilizing available military instruments in the most efficient combination against an actual enemy." To which he adds: "From the standpoint of preparation, technique is a problem of weapon type, material, and organization. From the standpoint of utilization it is a problem of mobilization, strategy, and tactics."[2]

Though in its fullest meaning the word "armament" includes the whole paraphernalia of war—the sea, land, and air forces of a nation—in this study I intend to adhere to its more restricted sense; namely, the weapons and ancillary means by which battles are fought and wars waged. "A military instrument," Wright defines, "is a material or social entity used by a government to destroy or to control by threats or violence another government or to ward off such destruction or control."[3] And Rear Adm. Bradley A. Fiske has written: "If used to guard or attack, an implement becomes a weapon—a weapon is merely a tool for a warlike purpose."[4]

Personally, I prefer an even more restricted definition: "An instrument with striking power." Thus a shield or a helmet is not a weapon but a means of protection, nor is a ship, a tank, or an airplane a weapon, for they are no more than vessels or vehicles to carry weapons. Nevertheless, the dividing lines between hitting, guarding, and moving are fine, and, as the mechanization of weapon power proceeds, are daily growing finer.

In order to trace armament development clearly, the simplest way is to begin at the beginning—the fight between two unarmed men; that is, between fighters whose sole weapons are their hands, feet, and teeth. At once it will be seen that to guard, to strike, to hold, and to move are its tactical elements. To these may be added the moral elements of will, tenacity, terror, and, later on, when the fighters take to throwing stones, the economic element of supply —first, the supply of missiles (munitions), then of men, and lastly of food.

In turn, these elements can be endowed with "striking power," for the will of an enemy can be attacked by yells, invocations, and acts of calculated cruelty, and his stomach by pillage, devastation, and blockade.

With reference to this, it is of interest to note that during the eleventh century, anathema, excommunication, and interdict—all moral weapons—were in "striking power" far more formidable than weapons of the commoner sort and that, in the war of 1914-1918, the Allied blockade was of all the "weapons" employed the most powerful in effecting the collapse of the Central Powers.

TACTICALLY, unarmed man is less well endowed than many of the animals, whether herbivorous or carnivorous. He has not the strength of the bull, the hide of the rhinoceros nor the teeth and claws of the tiger. Yet, because he is more intelligent than they, he has conquered them. As his struggle with the animal world has shown, once he took to making weapons his cunning overcame even the most savage of beasts, leaving the prolific—the rabbit, rat, mosquito, and bacillus—rather than the powerful as his most formidable enemies. Even today the science which is his is still at grips with them. Thus, in its way, reproduction is also a weapon and the one which possesses the most potent survival value.

Whether we accept the Biblical account or the Darwinian theory of man's origin makes no great difference, for as long as Adam inhabited Eden or ape man the jungle—in either case in an unarmed state—without his superior intelligence, his supreme weapon, man could not have survived. In turn, his tactical weakness must have stimulated his cunning, forcing it to develop until, from the defensive existence of the hunted, he was able to assume the offensive life of the hunter. As Thomas Carlyle wrote: "Savage Animalism is nothing; inventive Spiritualism is all."[5] Therefore, I think Bergson is right in ascribing the appearance of man—the human being—"to the period when the first weapons, the first tools, were made."

General Fuller is author of the following works, among others: "On Future Warfare," 1928; "India in Revolt," 1931; "Lectures on F. S. R. II," 1931; "Lectures on F. S. R. III (Operations between Mechanized Forces)," 1932; "War and Western Civilization, 1832-1932," 1932; "General Grant (A Biography for Young Americans)," 1932; "The Dragon's Teeth (A Study of War and Peace)," 1932; "Generalship, Its Diseases and Their Cure," 1933; "Grant and Lee (A Study in Personality and Generalship)," 1933; "Empire Unity and Defence," 1934; "The Army in My Time," 1935; "The First of the League Wars," 1936; "Memoirs of an Unconventional Soldier," 1937; "The Last of the Gentlemen's Wars," 1937; "Towards Armageddon," 1937; "The Decisive Battles," 1939; "Decisive Battles of the U. S. A.," 1942; "Machine Warfare," 1942; "Armored Warfare," 1943. Special correspondent, London *Daily Mail*, Italo-Abyssinian War. Major General, British Army, Retired. C. B., C. B. E., D. S. O. London, England.

[1] Reference notes are published in full on page 79.

Carlyle is of the same opinion when in "Sartor Resartus" he makes his imaginary professor say: "Man is a tool-using animal . . . feeblest of bipeds! Three quintals are a crushing load for him; the steer of the meadow tosses him aloft, like a waste rag. Nevertheless he can use tools, can devise tools. With these the granite mountain melts into light dust before him; he kneads glowing iron, as if it were soft paste; seas are his smooth highway, winds and fire his unwearying steeds. Nowhere do you find him without tools. Without tools he is nothing; with tools he is all."[6]

WHAT, then, was his first tool and weapon? For in the beginning industry and war were one, as today they are once again verging toward unity. Like Lewis Mumford, many suppose "the first efficient tool . . . to have been a stone held in the human hand as a hammer."[7] Yet there is a possible alternative. Did the discovery of making fire precede that of the stone hand-hammer? Or again, did Thor and Prometheus descend from heaven arm in arm? For to strike certain stones together is the simplest way of producing a spark. As Dr. Nicolai writes: "Not domestic animals but fire it is which makes man lord of the world. When man first caused the solar energy stored up in plants to explode and catch fire, he opened up for himself a novel source of power, and this lent such an extraordinary impetus to the conversion of energy that we are quite entitled to speak of things in general having taken a new turn and to date the mastery of nature from the kindling of the first fire."[8]

Mumford writes much the same: "Prometheus, the fire bringer, stands at the beginning of man's conquest: for fire not merely made possible the easier digestion of foods but its flames kept off predatory animals, and around the warmth of it, during the colder seasons of the year, an active social life became possible beyond the mere huddle and vacuity of the winter's sleep."[9]

There is yet a third alternative. For tens of thousands of years jungle man must have watched burrowing animals, such as rabbits, emerging from and seeking shelter in their holes. His more likely way of killing them would be to seize them as they crept out. This may have led to his digging holes with his hands or with sea shells, stones, and bits of bone or of broken wood in order to trap his prey.

Thus we have three possible tool or weapon origins—the hammer, fire, and the spade. Which can claim priority we cannot say; yet all three have since their first use been steadily and progressively developed in war.

Once tools and weapons came into being, it is not possible to imagine any tribe or race of men remaining for long unarmed, for without weapons its members would have been rapidly exterminated. This means that to be armed was to be endowed with a survival value, a condition which still holds good and which, as we shall see, has profoundly influenced history.

Further, once tribes were armed—that is, tooled—law and order within them could be enforced. As Machiavelli wrote: "There cannot be good laws where there are not good arms, and where there are good arms there must be good laws."[10] In other words, the weapon was the originator of police power; in turn, to prevent the policeman revolting against the order he protected, the laws upon which it was based had to be acceptable to him. Thus, by means of weapon power rather than through agriculture, we find man stepping onto the road to civilization—toward the establishment of a law-abiding and not merely a food-producing society.

For ages on end agricultural implements and weapons of war must have remained identical. Nor was this identity confined to the most primitive conditions of culture, for in the *Book of Samuel* we read: "Now there was no smith found throughout all the lands of Israel (for the Philistines said, Lest the Hebrews make them swords or spears). But all the Israelites went down to the Philistines, to sharpen every man his share, and his coulter, and his ax, and his mattock."[11] Thus was the army of Saul and of Jonathan armed.

Many parallels to this are to be found up to the present day, for in 1940 when the great invasion scare swept England, in its earlier stage farm laborers and others armed themselves with pitchfork, ax, and billhook to settle with German paratroops should they descend.

A typical example of the arming of a popular rising is that of the short-lived yet highly dramatic rebellion of Masaniello against the government of Naples in 1647. Of it we read: "The soldiers march'd with their drawn swords, their muskets and arquebuses cock'd, and arm'd likewise with lances and targets . . . the country people thronged into the town in great multitudes . . . armed with plowshares, pitchforks, spades, pikes, and other implements . . . Nor were the women . . . backward in their zeal: for they assembled in great numbers furnished with fire shovels, iron tongs, spits, and other family instruments . . . Even the very children were seen with canes and sticks in their hands, threatening the nobility and urging their fathers to battle."[12]

From this it will be seen that the number of potential weapons is incalculable, for anything which can be brandished or thrown can be used in a fight. Notwithstanding, for practical purposes the bulk of all weapons may be grouped into two primary classes; namely, shock and missile (including their projectors), the former being used for infighting and the latter for outfighting. Of the first, the more common are the club, mace, spear, lance, sword, ax, pike, and bayonet; and of the second, the pebble, javelin, arrow, bolt, ball, bullet, bomb, and shell. The first may be called individual or single weapons, whose striking power is derived from human muscle; the second, dual weapons, weapons which are propelled by mechanical or chemical energy—tension, tortion, or explosion. Though there are certain weapons which fit into neither of these classes, such as the lasso, bolas, and blowpipe, the two main secondary groups are (1) fire, asphyxiants, and poisons, and (2) traps, snares, nets, and mines. Roughly, the first may be called "chemical weapons" and the second "weapons of stratagem."

THE powers and limitations of the majority of these instruments of war, and more particularly of the single and dual weapons, may be classified under the following headings: Range of action, striking power, accuracy of aim, volume of fire, and portability.[13] These may be defined as follows:

Range of action: The greater the reach or range of a weapon, the more speedily can striking power be developed. *Striking power:* The greater the striking power of a weapon, the more effective will be the blow struck. *Accuracy of aim:* The more accurately a weapon can be aimed—that is, thrown or projected—the more likely is it that the target will be hit. *Volume of fire:* The more the number of blows dealt or missiles thrown or projected in a given time, the greater the effect is likely to be. *Portability:* The more easily a weapon can be carried, hauled, handled, and wielded, the

less will be the energy expended in its employment in combat.

Of these, the first may be called the dominant characteristic, that is, the characteristic which dominates the fight. Therefore the parts played by all other weapons should be related to the dominant one. Otherwise put, the weapon of superior reach or range should be looked upon as the fulcrum of combined tactics. Thus, should a group of fighters be armed with bows, spears, and swords, it is around the arrow that tactics should be shaped; if with cannon, muskets, and pikes, then around the cannon; and if with aircraft, artillery, and rifles, then around the airplane.

The dominant weapon is not necessarily the most powerful, the most accurate, the most blow-dealing, or the most portable; it is the weapon which, on account of its superior range, can be brought into action first and under the protective cover of which all other weapons, according to their respective powers and limitations, can be brought into play. Further, the higher its striking power, accuracy of aim, volume of fire, and portability, the more dominant will the weapon be.

Thus, today, because of all weapons the aircraft bomb possesses superior range and because its striking power is enormous and its movement easy, it is the dominant weapon. Set against these powers are the following limitations: the low accuracy of aim and low volume of fire of the airplane as a projector. The second of these is due to the limit of the bomb load, because the airplane, once its bombs have been "fired," has to return to its base to reload. Could these limitations be surmounted, then the airplane would become what may be called "a master weapon"—that is, a weapon which monopolizes fighting power. Such weapons have appeared from time to time, but their effective reign has generally been short. Thus, we shall see that Greek fire, the cannon, the ironclad ship, and the rifle have, in certain circumstances, either attained or closely approached this ideal.

These characteristics of weapon power should be borne in mind when tactics are considered—that is, the combined use of weapons. This use introduces the problems of protection, of holding—ability to stand firm or to halt—and of movement.

Being hairless and virtually hideless, of all animals man is the least protected, and, as for a vastly longer period of time he was the hunted and not the hunter, his protective problem must have greatly predated the invention of weapons. By making himself invisible, by seeking his food at nighttime, by living in caves and trees, by developing his voice—using yells and then words as moral weapons—and by clothing himself in skins he may have protected himself in the early ages.

As his condition was one of perpetual wardom, he had to be in a constant state of readiness to fight and, therefore, to live in a permanently protected order. His first village was, consequently, a fort built in a swamp, on an island, on the margin of a lake, or on a hilltop. Later, he banked his settlements in, built castles, fortresses, Great Walls of China, and Maginot Lines. He did these things so that he might stand firm and thereby hold off his enemy until his food was exhausted or until he himself was ready to fight. Thus, the inaccessible village, the moated settlement, the walled city, and eventually the fortified country became not only his bases of war but also centers of his civilization.

In turn, this protective idea was carried into the field, first, no doubt, in the form of a stick or branch or rawhide used to ward off blows and later, when implements appeared, in the fashioning of shields, helmets, and ultimately of body armor, until we arrive at the medieval man-at-arms armored *cap-à-pie*—the human armadillo—and later on the tank.

IT needs no argument to prove that, should other things be equal, a man armed with a sword alone is no match for an opponent armed with sword and shield. This simply means that protected offensive power is superior to unprotected offensive power. It is only necessary to carry this truism a step further in order to appreciate that when a body of men replaces the individual fighter, should it be organized into two groups, the one offensive and the other defensive, the latter may be formed into a protected base from which the former can operate—that is, a harbor to set out from and to return to. Thus is established the primary tactical division between the fighters; they are divided into those who can better deliver blows and those who can better withstand them. The one hits, the other holds; the one moves, the other stands firm.

As reach or range is the dominant characteristic of an offensive weapon, speed and mobility in attack are the dominant characteristics of the offensive itself. Thus, to quote General Lloyd:

"The first problem in tactics should be this: how a given number of men ought to be ranged so that they may move and act with the greatest velocity; for in this chiefly depends the success of all military operations. An army superior in activity can always anticipate the motions of a less rapid enemy and bring more men into action than they can at any given point, though inferior in number. This must generally prove decisive and ensure success."[14]

The first radical change in mobility came with the taming of the horse and its use in war either to haul chariots and supply vehicles or to carry a rider. As we shall see, this innovation revolutionized warfare for it placed in the hands of the war chief two different forces of fighters—a mobile

THIS is the first of a series of six articles on the influence of armament upon history by Maj. Gen. J. F. C. Fuller, distinguished British soldier, tactician, author, and historian. Subsequent articles of the series will be published in the next five issues of ARMY ORDNANCE.

As will be seen from the text of this first article, General Fuller's keen analysis, broad experience, and brilliant pen are here at their best. The significance of his logic takes on new meaning now in the midst of war. It is especially opportune that readers of this journal have the benefit of his counsel at this time, for the success of our American armament in the present conflict and our attitudes toward it in the years to come may well decide the very existence of our Nation and our civilization.

Let us begin now, in the stark reality of war, to form a national policy of realism as regards the quality and quantity of our weapons. It was for this reason that General Fuller was asked to prepare his series of articles. The age-old lessons they emphasize must not again be quickly forgotten, or dishonestly misrepresented, or lightly tossed aside.—EDITOR.

force wherewith to exert pressure and a stable force wherewith to resist it. From this development eventually sprang another; the mobile force was divided into two bodies—a finding and a shock group—and the stable force also was divided into two bodies, a holding and a protective group. Until recently these groups were represented by light cavalry, heavy cavalry, infantry, and artillery. Today they are represented by aircraft, tanks, infantry, and artillery, including flying artillery—bombers.

Movement has been called "the soul of war," which is true, for movement is to organization what range is to weapon power—it is the governing element. Thus, when the energy from which military movements were derived was generated by muscle power, because the muscular energy of the horse was greater than that of man, tactical organization was built around that animal. This remained true as long as the range and volume of fire of missile weapons were limited, and it was not until the introduction of the rifled musket that the holding power of infantry became so great that cavalry movements were immobilized. When this occurred, as it did during the nineteenth century, tactical organization became decadent. It was based not on power to move but on ability to hit; therefore volume of fire became the be-all and end-all of the military organizer.

THE advent of the internal-combustion engine introduced a new source of energy many times superior to that of man or horse. And, from a military point of view, what was equally important was the invention of the endless-chain track, for it enabled the engine-driven vehicle to move in all directions over a comparatively smooth surface. Coupled with the ability to carry armor, a bulletproof "horse," called a tank, was created, and, as its power of movement was greater than that of the foot soldier, the whole existing military organization should have been remodeled around it.

Had the military organizer followed this pivotal idea, long before the second World War was unleashed he would have designed not only tanks—bulletproof cross-country combat vehicles—but also cross-country supply vehicles. He would not merely have thought of hauling artillery by means of tractors, armored or unarmored; he would have mounted his guns on bulletproof tracked vehicles. Further, he would have moved his infantry in somewhat similar vehicles. In short, he would have fashioned his new model army around the internal-combustion engine, armor, and the caterpillar track, as armies of the muscle age of war had been fashioned around the horse, armor, and the wheel.

As we shall see, this was not done because it was not realized that movement is the master element in organization.

Such, in brief, are the ingredients of armament—the power and limitations of weapons and the organizations in which they are expressed. Therefore, from them I will now turn to the general influence of armament on history.

In this problem, the first point to appreciate is that civilizations are cyclical and repetitive. Though each possesses an individuality of its own, each passes through similar phases of birth, growth, decay, and disintegration, in each of which war plays a dominant part.[15] As Quincy Wright has pointed out: "While animal war has required hundreds of thousands of years to register important evolutionary changes, civilized war has produced marked changes in the course of centuries —changes which have been registered in the stages of the civilization. These changes caused by war have reciprocally influenced the character of war. Thus, civilized war has been correlated primarily with the stages of the civilization in which it takes place. All civilizations have indulged in similar types of war when young, when middle-aged, and when old. The primary function of war has apparently been to assure these successions in the life of a civilization."[16]

WAR first unifies a people; lastly it disintegrates them. As long as it is the instrument of change, like a plow it tears up the social soil and thereby creates a more fertile field in which change can germinate. Consequently, the longer and more destructive a war is, the greater are the changes which follow it. But when each change is succeeded by a greater war, finally a state of wardom is established in which the military mind dominates. Then policy becomes the instrument of war, for, as Mumford points out, "In the act of making himself a master, the soldier helps create a race of slaves."[17] Change—that is, growth—is at an end, decay sets in, to be followed by disintegration. Such is the warp upon which armaments are woven.

From the cycles of civilization I will turn to history—a continuous and endless story in which these cycles are but chapters—and by examining it I will attempt to show the influence played by armaments throughout its course.

In perusing history as a whole, or any historical period, the first thing noticeable is that events are woven on a dual theme—peace and war. Further, with few exceptions, peace is little more than a period of incubation and preparation for war. This has been noticed by many historians and philosophers and notably so by William James. "Every up-to-date dictionary," he writes, "should say that 'peace' and 'war' mean the same thing, now *in posse*, now *in actu*. It may even reasonably be said that the intensely sharp competitive *preparation* for war by the nation *is the real war*, permanent, unceasing; and that battles are only a sort of public verification of mastery gained during the 'peace' intervals."[18]

The second thing which strikes us is that the character of war changes with civil progress and beliefs as they develop from out of the central idea in each cultural cycle. Thus, during medieval times war was circumscribed by religion, the central fact in which was the spiritual world; whereas today it is circumscribed by science, the central fact in which is the material world.

The third thing which strikes us, though at first not so obviously, is that as war is changed by civil progress, so also is civil progress changed by war; there is a reciprocal action between them. Further, war is the one permanent factor in its changings, for whether the period under examination be predominantly religious, commercial, or industrial, and whatever its political and social systems may be, war is never absent.

It is possible to have all manner of societies—theocratic, atheistic, plutocratic, communistic, democratic, autocratic, etc. —but, so far it has not been found possible to have a warless society. Again, whereas religious, political, economic, and moral systems not only change but at times vanish in their entirety, though military systems also change war is never annihilated. Except for brief periods of lassitude, the evolution of the weapons and means of war has been continuous and progressive. Further, the inventiveness which has always been stimulated by war has gone far to foster culture. On this point Mumford says: "How far shall we go back in demonstrating the fact that war has been the chief propagator of the machine."[19]

Signal Corps

THE 105-MM. HOWITZER HALF-TRACK TANK DESTROYER IS A PRODUCT OF MODERN WARFARE

As we glance over the records of man's activities, periods of peace and war follow one another in rapid and regular succession. Normally they represent but the roughs and smooths on the surface of the social ocean, yet now and again a sudden tornado of conflict is met with—a world crisis, revolutionary in its results. These world storms are not only due to the birth of some new religious or social idea, but at times also to some fresh acquisition in the munitions of war. Thus, according to Peake and Fleure, in all probability the great crisis in Europe which occurred between the fifteenth and thirteenth centuries B.C. was due to the arrival from central Asia of the horse and the sword.

According to these two historians, at the beginning of the second millenium B.C. the copper dagger in use in the Aegean region gave birth to the dirk, a longer weapon, and from the Aegean it spread throughout Central Europe. "The dirk was of obvious value to the pedestrian, but on horseback a slashing weapon would be more useful, and we think that it was somewhere among the horse-riding men of the later Bronze Age that the dirk gave birth to the sword."[20]

WHAT caused the great outpouring of warriors from the steppelands into India, Europe, Mesopotamia, Egypt, and probably also into China, is not known. One hypothesis is that it was due to climatic changes, and another that these warriors "had acquired the use of the horse and that, when they had combined this with a knowledge of metal, their power of conquering and organizing settled cultivators was immensely increased. . . In support of the second suggestion there is the evidence of the spread of the horse into India, Mesopotamia, Egypt, and Europe. . .

"The advent of the horse into Egypt seems to be associated with a change in the character of that country from that of a self-contained economy to that of the widespread empire, with strong military and commercial activities that developed under Hatshepsut and Thutmose. The consequent exchanges of thought, led on, apparently, to the famous attempt of Ikhn-aton to found a universal religion. . .

"The rise of the mounted spearmen and swordsmen in central Europe led to the supersession of the hammer or battle-ax, which had been the typical weapon of the steppelanders who had dominated a mining area on Slovakia for a considerable time. The new weapons used by horsemen seem to have opened up larger possibilities of conquest and organization, and the Hungarian basin of the Danube became a veritable melting-pot of cultures. . ."[21]

Though much of this, largely based as it is on archæological discoveries, is conjectural, when compared to analogous world crises it carries with it conviction. Thus, as we shall see, it was the armament of the Macedonians coupled with the genius of Alexander the Great which, by overthrowing the Persian Empire in the fourth century B.C., led to the emergence of the Hellenistic cultural period, which, when Rome conquered what today is represented by the Middle East, profoundly influenced her destiny. Again, as we shall see five centuries later, it was the armament of the Goths which was one of the main factors in the extinction of the Western Empire. Later still, it was the armament of the Eastern (Byzantine) Empire which secured its existence until 1453, when yet a new weapon not only proclaimed its end but also the end of medieval civilization throughout Europe. Finally, when we step into the present century, we shall see that once again it was a change in armament which radically revolutionized the art of war and at this moment is creating social, political, and economic problems which seem likely to transform the whole of existing civilization.

If war, then, which at bottom is a question of armaments, has been the grand catalytic in history, well may it be asked are there such things as laws, principles, or general rules which govern the development of weapon power? This

question I will now examine carefully and in some detail.

Because weapons are material things, their development is basically an industrial and scientific problem, a problem both of quantity and of quality. Thus, should two opposing forces be armed with identical weapons, then, other things being equal, the more numerous will overwhelm the less numerous. This mathematical principle, we shall see, fitted the democratic age—the century following the French Revolution—and was the main factor in the growth of mass armies. It has been expressed by Lanchester in his "N-square Law." "The fighting strengths of two forces," he writes, "are equal when the squares of the numerical strength multiplied by the fighting value of the individual units are equal." Therefore, ". . . the fighting strength of a force may be broadly defined as proportional to the square of its numerical strength multiplied by the fighting value of its individual units. . ."

"As an example of the above," he writes, "let us assume an army of 50,000 giving battle in turn to 2 armies of 40,000 and 30,000 respectively, equally well armed; then the strengths are equal, since $(50{,}000)^2 = (40{,}000)^2 + (30{,}000)^2$. If, on the other hand, the two smaller armies are given time to effect a junction, then the army of 50,000 will be overwhelmed, for the fighting strength of the opposing force, 70,000, is no longer equal, but is, in fact, nearly twice as great—namely, in the relation of 49 to 25."[22]

THE second part of the problem it would appear was first clearly expressed by Friedrich Engels, and, in spite of his Socialism, it is in character aristocratic; for, according to him, quality beats quantity and not merely a greater quantity a lesser. He set out to show "that force is no mere act of will but calls for very real conditions before it starts to work, in particular tools, of which the perfect one overcomes the imperfect one; that furthermore these tools must be produced, which means at the same time that the producer of more perfect tools, *vulgo* arms, beats the producer of more imperfect ones."[23]

This truism draws directly from the five weapon characteristics listed earlier in this study; yet, as far as I am aware, Engels was the first to set it down as the fundamental principle in weapon production. Although, since weapons were first used it was realized that a good weapon is to be preferred to a bad, before his day weapon progress largely depended on accident or individual genius—civil more so than military—far more so than on corporative scientific study. "It should seem," writes Lord Bacon, "that hitherto men are rather beholden to a wild goat for surgery, or to a nightingale for music, or to the ibis for some part of physic, or to the potlid that flew open for artillery, or generally to chance, or anything else, than to logic for the invention of the arts and sciences."

Were it not for man's unprogressiveness, it would be inexplicable that, though so important a military invention as the bridle bit dates from the early Bronze Age, if not still further back, saddles were unknown in Europe until the fourth century A.D. and then remained without stirrups until the reign of the Emperor Maurice (582-602 A.D.).

Generally speaking, it is only during wartime that a difficulty, which could well have been foreseen, awakens the soldier's inventive genius. And, then, as often as not, once the danger has passed the invention is forgotten. For example, in 54 B.C. the Britons used hot clay balls to fire Cæsar's camp;[24] in 69 A.D. igneous missiles were employed in the attack on Placentia;[25] in the year 630, when Mahomet lay siege to Tayif, the defenders had recourse to heated projectiles;[26] in 1579 Stephen Bathory, King of Poland, introduced red-hot cannon shot,[27] and in 1782 D'Arcon's floating batteries and a great part of the Spanish fleet were destroyed by red-hot shot fired from the batteries of Gibraltar. Nevertheless, so far as I am aware, incendiary projectiles were not recognized as a permanent weapon of war until the advent of aircraft.

During the first World War, this haphazard and unforeseeing procedure struck me so forcibly that I set down my views on weapon development in an official paper entitled "The Secret of Victory."[28] In it I wrote:

"Tools, or weapons, if only the right ones can be discovered, form ninety-nine per cent of victory. . . Strategy, command, leadership, courage, discipline, supply, organization, and all the moral and physical paraphernalia of war are nothing to a high superiority of weapons—at most they go to form the one per cent which makes the whole possible . . .

"In war, especially in modern wars—wars in which weapons change rapidly—one thing is certain: no army of fifty years before any date selected would stand 'a dog's chance' against the army existing at that date. . . Consider the following examples: (1) Napoleon was an infinitely greater general than Lord Raglan; yet Lord Raglan would, in 1855, have beaten any army Napoleon could have led against him, because Lord Raglan's men were armed with the Minié rifle. (2) Eleven years after Inkerman, Moltke would have beaten Lord Raglan's army hollow, not because he was a greater soldier than Lord Raglan, but because his men were armed with the needle gun.

"During the present war we have had a series of vivid pictures thrust under our noses in such rapid succession and so close to our eyes that it is extremely doubtful whether many of us have read aright what they portend; namely, 'that it is machine power and not man power which wins in war' . . . that war is primarily a matter of weapons, and that the side which can improve its weapons the more rapidly is the side which is going to win."

IN spite of this truism, so unscientifically minded were the English and French that, between the years 1919-1939, little attempt was made to mold their respective armies around it. In 1940, the result was Dunkerque and the collapse of France.

Even had the British alone possessed a small quality army of but a third the size of the quantity army they sent to France, the probabilities are that there would have been no Dunkerque, and the possibilities are there might well have been a German Sedan. But had the British had a quantity army several times larger than the one they landed, though the debacle of France might have been delayed, it is highly unlikely that it would have been altogether prevented.[29]

The reason for this lack of foresight was that, between the two wars, the development of French and British military power was unscientific because it was not appreciated that war is endemic in Western civilization and that, apparently, the French and English General Staffs were oblivious of the fact that throughout history the evolution of weapons has been governed by a law, which I will call the law of military development.

It is common knowledge that man is influenced by his surroundings and that should he consciously fail to adapt

himself to them, unconsciously he will be adapted by them. This knowledge is generalized in the law of evolution, which simply means that those who adapt themselves the more rapidly and perfectly to material, intellectual, moral, and physical changes, more readily survive. In the life history of military organizations, which are corporate entities, it is the same: civilization is environment, and armies must adapt themselves to its changing phases in order to remain fitted for war.[30]

When civilization depended upon brigandage more so than on trade, as it did in early medieval times, and when roads were few and generally unfit for wheeled traffic, military power was founded on mounted troops. When this epoch was succeeded by a more stable agricultural one, infantry became the dominant arm. Lastly, after the industrial revolution set in, as manufacture grew and grew and because it is based on science and inventions, it was a foregone conclusion that, to survive in war, armies would have to follow suit and become more and more mechanized. That they did not was due to lethargy and routine.

From this law may be deduced a principle which I will call the constant tactical factor: "Every improvement in weapon power has aimed at lessening the danger on one side by increasing it on the other." Therefore, every improvement in weapons has eventually been met by a counter-improvement which has rendered the improvement obsolete —the evolutionary pendulum of weapon power slowly or rapidly swinging from the offensive to the protective and back again in harmony with the speed of civil progress, each swing in a measurable degree eliminating danger. Thus, in the days of the Stone Age, when progress stood all but at a standstill, weapon development was proportionately slow and may be said to have been always up to date.

TODAY, conditions are diametrically reversed, for civil progress is so intense that there is not only a danger but a certainty that no army in peacetime can in the full sense be kept up to date. This means that, in wartime, evolution will be extremely rapid and, therefore, that the army which is mentally the better prepared to meet tactical changes will possess an enormous advantage over all others.

As an example of this, it is only necessary to quote the astonishing German campaigns which preceded the invasion of Russia in 1941. They were not won by mass armies, but instead by comparatively small forces of highly offensive troops. Thus, in the most decisive of them—that against France—the Germans would appear to have employed no more than ten armored divisions and there can be no question that they were the main cause of the French collapse. This in part is corroborated by the insignificance of the German casualties, which were reported to be 27,074 killed, 111,034 wounded, and 18,384 missing: a total of 156,492, or less by over two-thirds than those sustained by the British during the Battle of the Somme in 1916.

From the offensive to the defensive and then back again to the offensive is the normal rhythm in tactical development, and it is this rhythm which has had the profoundest influence in shaping history. As Quincy Wright and others have pointed out, superiority of attack over defense has favored political unification, whereas superiority of defense over offense has led to political disintegration. Further, by prolonging a war the defensive has increased destructiveness, not only physical but also moral.

Finally, "the importance of success in war in the survival of states has tended to spread military discipline and organization by conquest and imitation throughout the civilization"[31] until eventually a condition of international wardom is established in which the staple industry is the production of arms. When this finality is reached, war from a means to an end becomes the end itself. Its survival value passes into a death value, and, morally and politically, victor and vanquished immolate each other on the selfsame altar.

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[1] "On War," Carl von Clausewitz (English translation, 1908), pp. 84-85. [2] "A Study of War," Quincy Wright (1942), Vol. I, p. 501. [3] *Ibid.*, Vol. I, p. 291. [4] "The Art of Fighting" (1920), p. 12. [5] "Sartor Resartus," Chap. VIII. [6] *Ibid.*, Chap. V. [7] "Technics and Civilization" (English edition, 1934), p. 65. He adds: "The German word for fist is *die Faust*, and to this day the miner's hammer is called *ein Faüstel*." [8] "The Biology of War," Dr. G. F. Nicolai (1919), pp. 52-53. [9] "Technics and Civilization," Lewis Mumford, p. 37. [10] "The Prince," Niccolo Machiavelli, Chap. XII. [11] *I Samuel*, XIII, 19-20. [12] "The History of the Surprising Rise and Sudden Fall of Masaniello the Fisherman of Naples," p. 38. [13] So far as I am aware, Lord Bacon is the first to consider weapon power scientifically. In his essay "Of Vicissitude of Things," he writes: "The conditions of weapons and their improvements are, first, the fetching afar off; for that outruns the danger, as it is seen in ordnance and musketry. Secondly, the strength of the percussion. . . The third is, the commodious use of them, as, that they may serve in all weathers, that the carriage may be light and manageable, and the like." [14] "History of the Late War in Germany," General Henry Lloyd (1790), Part II, p. 2. [15] See in particular Oswald Spengler's "Decline of the West," and Prof. Arnold J. Toynbee's "A Study of History." [16] "A Study of War," Quincy Wright, Vol. I, p. 126. [17] "Technics and Civilization," Lewis Mumford, p. 95. [18] "Memories and Studies," William James (1911), p. 411. [19] "Technics and Civilization," Lewis Mumford, p. 86. [20] "The Horse and the Sword," Harold Peake and Herbert John Fleure (1933), p. 86. [21] *Ibid.*, pp. 143-145. [22] "Aircraft in Warfare—The Dawn of the Fourth Arm," Lanchester (1917), p. 222. [23] Quoted by Alfred Vagts, "A History of Militarism" (1938), p. 227. [24] "De Bello Gallico," Caius Julius Cæsar, Book V, 43. [25] "The History," Tacitus; Book II, 21. [26] "Life of Mahomet," Sir William Muir (1858-1861), p. 432. [27] "The Origin of Artillery," Lieut. Col. Henry W. L. Hime (1915), p. 173. [28] "Weekly Tank Notes," January 25, 1919. See also "On Future Warfare," J. F. C. Fuller (1928), Chap. VII. [29] I have been criticized because before the war I advocated a small army in place of the mass armies of 1914-1918. Certainly I did, but not a small army only, but a small *mechanized* army, which makes all the difference. When a soldier sets out to propose the type of army required for the next war, rightly he considers the opening phase of that war, and not those which, because of the nonacceptance of his ideas, follow it. [30] As Spengler points out: "In every culture, the technique of war hesitatingly followed the advance of craftmanship, until at the beginning of the civilization it suddenly takes the lead, presses all mechanical possibilities of the time relentlessly into its service, and under pressure of military necessity even opens up new domains hitherto unexploited. . ." "The Decline of the West" (English edition), Vol. II, p. 420. [31] "A Study of War," Quincy Wright, Vol. I, p. 129.

New Antitank Weapons

The Army has recently disclosed the development of a 4-wheeled version of the 90-mm. antiaircraft gun, above, enabling it to be used also as an antitank weapon. Below, the German 88-mm. rocket launcher is shown with the American bazooka beside a captured German Mark VI Tiger tank—Germany's largest—which the bazooka can destroy (Ordnance photos).

Pattern For Victory

Vindication of the Ordnance Procurement District System

Maj. Gen. L. H. Campbell, Jr.

THIS section of the Empire State has established such a preëminent record toward winning the war that I have long anticipated this opportunity to express gratitude and appreciation. As Chief of Ordnance of the United States Army I do so now with a full heart. Industry in this area has coöperated with the Ordnance Department to the greatest possible extent. When the history of our great war record is written, your coöperative effort will loom large on nearly every page. Without the work that you have done and are doing, our fighting equipment could not have placed our fighting men in the favorable position in which they now stand poised in Europe and the South Pacific.

Two great Ordnance influences have been at work in this area through many years. Together they have trod the road of industrial preparedness. Tonight I wish to pay tribute to both. One is the Rochester Ordnance District of which you in Buffalo are a most important part. The other is the Army Ordnance Association of which many of you are members.

Of the Army Ordnance Association I can repeat what I have said publicly about it on many occasions. It has been, is now, and I am confident always will be, the vanguard of industrial preparedness in this country. Despite its important record during the past quarter of a century, its greatest service to our country is yet to be performed. As a technical and scientific society devoted solely to the interests of industrial preparedness it will be looked to in the days to come to lead the thinking, to assist in the planning, and to preserve the doctrines of armament research, production, and maintenance as we have learned them in this war.

Therefore the Association must be strong in membership adequately to carry such a burden. Many of you have assisted nobly in the work of this society for many years. A proper appreciation of the importance of armament in the days to come will require a strong group of our citizens to make certain that the pitfalls and delays—overcome the hard way in this war—are not experienced again. We of the Ordnance Department have always welcomed such help, and I can assure you that during my tenure as Chief of Ordnance I shall lean heavily upon your counsel and advice. Knowing the responsibilities of my office as I do, I am confident that my successors in the years to come will appraise your efforts with thanks and appreciation as deeply as I do and as all my predecessors have done without exception since the Association was founded in 1919.

American industry and the Ordnance Department have accumulated an experience in arms production the like of which has not been available ever before in our country or in any other country. We must sustain that experience and profit by it in the hope that in any wars in which we are compelled to fight in the future the cost of victory will be far less to us in men, materials and money than this present war. No greater obligation rests upon any of our citizens, and none is a more certain guarantee of victory in this war, of peace in the years to follow, and of victory in any future war.

I have here with me some Ordnance officers who are doing fine work for the Department at Washington. All of them are native sons of Buffalo, and I want to present them to you as fine examples of some of the Buffalo boys who have made good. They are: Col. I. A. Duffy, Col. H. B. Sheets, Lieut. Col. G. F. Phillips, Lieut. Col. C. P. MacArthur, Lieut. Col. P. B. Taber, Maj. W. H. Culbertson, and Capt. E. G. Zeller.

Col. Frank Atwood has been in charge of this Ordnance district for nearly two years. He has directed its operations through a most critical period and continues to direct them with energy and distinction. Industry in this area looks to him for direction in ordnance production. He has full power to act. The promptness and soundness of his decisions in the past and the alacrity with which he has met all urgent demands are the best proof I know of that industry relies upon him as I know he does upon it. The results achieved in this district under his leadership speak louder than any words of mine. I am grateful to him and to his deputy, Col. Arthur J. Schamahorn for a great job being done well. I am grateful also to the officers of the district and to all personnel of the organization, military and civilian.

NOW let me speak briefly about the Ordnance district system. It is unique in the annals of American government; it has produced results equal, I should say, to those of any other one segment of our Federal establishment, and it has set the pattern for coöperation in the production and supply of armament which bids fair soon to bring victory to our heroic fighting men. Whenever D-day comes you will not have underestimated the case if you say it would have been delayed at least six months if the Ordnance district system had not been at work for the past quarter of a century. It is the cornerstone of Industry-Ordnance coöperation.

Let us consider briefly the beginnings of the Ordnance district system and its evolution in the days prior to this present war. In the spring of 1918 it became apparent that the Ordnance job at that time was far too great for operation from a central point at Washington. A great industrial leader was chosen by the Chief of Ordnance to decentralize our Ordnance procurement activities. The chairman of the Westinghouse Electric & Manufacturing Company, Guy E. Tripp, was selected to bring about the decentralized organization. Under the guidance of a great Chief of Ordnance, Maj. Gen. C. C. Williams, fourteen industrial centers were chosen from which these decentralized operations would be conducted. These district areas followed the plan of American business along the lines laid out by the Federal Reserve System. In each of these areas a local manufacturer of outstanding ability was chosen as district chief, and in his hands, aided by a competent staff of military and civilian personnel, was placed the responsibility of conducting the vast procurement and production Ordnance operations of those days.

Industry assisted nobly through all the years in this vital

General Campbell is Chief of Ordnance of the U. S. Army. This is an address delivered before a meeting of the Empire Post of the Army Ordnance Association, held at the Hotel Statler, Buffalo, N. Y.

work. Its leaders served gratuitously as members of our district advisory boards. It participated in all our studies for the allocation of war orders among types of industries normally far removed from armament production. It gave unstintingly of its resources and of its ability and its facilities to further this work and then stuck to the job for more than twenty years in a day when most of our compatriots were harboring the delusion that wars were to be no more.

Here and now on this twenty-sixth anniversary of the establishment of the Ordnance district system you can make this boast without hesitation and without fear of contradiction: Had it not been for the work so loyally and so constantly done for so many years by the Ordnance districts, this present war would not have been in the advanced stages toward victory in which it now is. Had it not been for the self-sacrifice, the loyalty, and the persistence of American industry and the Ordnance Department operating through the Ordnance districts, our plans for invasion would have been much longer delayed. The Ordnance districts deserve a lion's share of the credit for the fact that today, 29½ months after Pearl Harbor, the American Army stands on a score of battlefronts the strongest in armament of any army in the history of the world. If vindication of the system ever were needed, that is its vindication!

ONE of the greatest contributions of the Ordnance district system was our prewar planning for the production of armament in the event of war. One month after the first large Ordnance appropriation in the Nation's armament program was approved (September 9, 1940), seventy per cent of the Ordnance orders had been placed with industries and Government arsenals, and ninety-five per cent of these orders were placed with manufacturing facilities, large and small, previously surveyed by the Ordnance Department and tentatively allocated to them under the Industrial Mobilization Plan.

How vast this system is is shown by some comparative figures: The value of contracts being administered by the Ordnance districts at the end of March 1944 was $17,649,098,945.23. The value of all contracts as of October 1942 was $18,921,593,253.68. The number of prime contracts for which the Ordnance districts are conducting inspection was 19,624 for March 1944 as compared to 19,895 for October 1942.

A most remarkable thing, I think, is that despite this tremendous production load the man power involved for district office employees and plant inspection—again using the same months for my comparison—was reduced from 44,220 in October 1942 to 27,603 in March 1944. This is an indication of the efficiency and economy which is evident in all our Ordnance operations. It is also a sign that we in Ordnance are striving constantly to utilize the Nation's man power for a maximum war effort.

Do not by any means conclude that the Ordnance production job is finished. It is not. In this district alone during the last month a total of 272 Ordnance production contracts were awarded having an approximate net value of $25,500,000. In the field of ammunition for heavy artillery especially, manufacturers in this district are busily engaged in helping us meet most urgent requirements from the battlefields.

You will be interested in knowing the dollar value of some of the principal Ordnance products produced in this district during last month. More than $5,500,000 was for artillery ammunition, $2,500,000 for artillery, $15,000,000 for small arms, $7,000,000 for tank and motor transport, and nearly $1,000,000 for miscellaneous Ordnance items. All told, last month's Ordnance job here represented more than $30,000,000 worth of fighting equipment for our services and those of the United Nations. There must be no complacency about Ordnance production until the last shot in the last battle is fired.

As we gather to commemorate twenty-six years of operation of the Ordnance district system, American fighting men await the greatest battles of world history. It is not a time for boasting. This is an hour of faith and of hope. You of industry and we of Ordnance have unitedly welded ourselves into a team which is producing in quantity and quality superior weapons of tremendous firepower. The best weapons in the hands of heroic fighting men can make victory less costly by reducing the number of lives lost in battle, in lowering the number of wounded, and in driving a determined enemy to submission. Many of you have your own sons and brothers on the battle lines and on the beachheads at this hour. The fighting equipment you have produced here and elsewhere throughout American industry is ready to do its part; so also are our American soldiers. Our infantrymen, our artillerymen, our airmen, our doctors, our engineers, our ordnancemen, and all the rest. We need have not the slightest doubt of the outcome. I never have had any doubt because I know the quality of our soldiers, sailors, and airmen, and I know, too, the quality of their weapons.

I repeat again that when victory comes—as it will come, and we all pray soon—you may say that it will be at least six months sooner than it would have been because of the work done by the Industry-Ordnance team here and throughout the country, by the Ordnance districts during every day of the past twenty-six years. In the days to come, the Ordnance districts must continue on—they must be maintained and supported for the advancement of the Industry-Ordnance team as an essential of our national defense.

For your part in the marvelous achievement of the Industry-Ordnance team, our people will thank you always. We of the Ordnance Department do thank you in a special way because we know intimately the sincerity of your purpose, the self-sacrifice of your energy, and the quality of your determination. Such a combination is bound to win. Keep your faith firm and your hope high!

EDITOR'S NOTE.—In an article on "Ordnance Firepower in Battle" published in the January-February 1944 issue of ARMY ORDNANCE (Vol. XXVI, No. 142, p. 69), General Campbell wrote:

"Ordnance production, month by month, gives ample evidence that there is no letup. In some of our plants, production has attained almost unbelievable goals. Management is applying all the controls for which the Industry-Ordnance team is known. Those controls must be continued! Efficiency of operation and economy are still guiding principles in our progress. We must be careful of the taxpayer's interest, and we must weigh every dollar of expenditure of Government funds as carefully and zealously as though they were our own. As the demands from the battle fronts change, so also must we meet those changes instantly.

"Our ordnance-production curves are up; our man-power curves are down. Our unit-cost figures constantly grow less. The Ordnance dollar, day by day, shows an increasing return, not only to the man on the battlefield but to every American taxpayer throughout the land. Such goals are basic in our Industry-Ordnance operations, and they will continue to guide our course throughout this war."

Economy in Weapon Production

The Reductions in Cost of Arms and Ammunition

Maj. A. R. Coleman

IT is natural that the prices of small arms and ammunition are and have been in a "goldfish bowl," for these are items which the layman generally can comprehend. This general interest has had a healthy effect, as it has emphasized the necessity of a continuous review of the "rightness" of small-arms prices. It has, however, been trying at times to explain in a few words the differentials in individual prices which can justifiably exist and which are part and parcel of the design of the item, of the tooling used in its manufacture, and of all the conditions under which it has had to be produced during the course of a war emergency.

For sake of a proper perspective, it should be noted that the prime responsibility of Ordnance has been the production job. The important thing, and the accomplishment which really counts, is that small arms and ammunition have come off the production line in the quantities demanded, of the quality desired, and in the time allotted.

It should be a source of additional gratification to all who have made it possible that the prices of small arms and ammunition have declined *forty-eight per cent* over the last three years.

Typical of the entire range of small arms and ammunition is the course of prices for a group of fifteen major small-arms items as indicated in Fig. 1. These are the fifteen small-arms items which are most important money-wise. As a group, they represent seventy-three per cent of the total money value of the program accomplished during 1941-1943 and the program planned for 1944-1945 by the Small Arms Branch of the Ordnance Industrial Division.

The forty-eight per cent decline in prices since 1941 or the forty-one per cent decline since 1942 answers the general query: "What has been the course of small-arms prices over the last three years?" It still does not answer such a specific question as "What has happened to the price of the caliber .50 aircraft machine gun over the same period?" The answer to this type of question is shown graphically in Fig. 2 in the series of charts which show the relative changes in price for each of the fifteen major items between July 1, 1941, and April 1, 1944. Since individual actual prices are not ordinarily published, they are not used in this article. The percentage comparisons used are based upon composite average prices of all producers of each item as used in the preparation of official budget estimates. Since the charts by themselves do not tell the whole story, let us consider the following items in some detail: machine guns, rifles, metallic belt links, and small-arms ammunition.

The *caliber .50 aircraft machine gun,* the most important single item of small-arms procurement, is now being procured at 40 per cent of its prewar price. The prewar price represents, for the most part, high initial costs incurred by a number of new facilities which were "tooled up" in 1940 and 1941. These new facilities were well planned, and the results of this are evident in the subsequent lowering of manufacturing costs and contract prices. This lowering of manufacturing costs has been realized during the build-up to peak volume, and has persisted since.

As the value of basic raw material constitutes only about ten per cent of total cost, the continuing reductions realized must be attributed to savings in the number of man-hours required to produce the weapon. In addition to the economies obtained as a result of increasing volume, many improvements in manufacturing techniques have contributed to the savings in man-hours, costs, and prices, as for example:

(1) Broaching the barrel instead of using conventional rifling methods. (2) Using an improved-type chambering machine requiring a shorter setup time. (3) Using, instead of forgings, specially heat-treated malleable castings produced under closely controlled processes. These are cast closely to size, and the material is easy to machine, with resultant savings in materials, machine time, and machine tools. These castings are used in place of about seventy-five per cent of forgings formerly used. (4) Using, for the side plates of the gun, a lighter flat plate which is "upset" by automatically controlled induction heating to obtain the thicker section of the side plate adjacent to the back plate of the gun. Formerly, heavier plates were used and machined down for 95 per cent of their length. (5) Using for the jacket tube flat plates which are punched for the perforations, then rolled and welded. Formerly, seamless tubing was used, and the perforations were drilled.

THERE has been a continuous improvement in the quality of the weapon, and the real decreases in costs attained are, therefore, actually greater than those indicated in Fig. 2. The remarkable performance of the gun reported from the battle zones evidences the emphasis placed on quality. This emphasis on quality has been accentuated, moreover, by the demands for even greater performance as the number of guns used per plane, as well as the lengths of loaded belts, and therefore belt lifts, have increased. Indicative of the improved quality of the weapon are the increase in rate of fire, which has been stepped up from 650-750 rounds a minute to 950, and the increase in belt-lift load from 14 pounds to 20 pounds. These improvements have been accomplished with some additional costs as it has been necessary to grind critical functioning surfaces in order to maintain uniformity and to build into the gun the reserve required when adverse conditions are encountered in combat.

The decrease in cost of the *caliber .50 heavy-barrel gun* has paralleled that of the caliber .50 aircraft gun. Except for the barrel and a few other components, the parts for the heavy-barrel gun are identical with the parts for the aircraft gun. It has so happened, however, that the heavy-barrel gun has been produced in areas of greater labor stringency than has been the case generally with the aircraft gun. As a consequence, the differences in labor rates paid have operated to retard the relative rate of decline for the heavy-barrel gun as compared with the aircraft gun.

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The radical reductions in costs for the *caliber .45 submachine gun* have resulted primarily from changes in design. Originally, the item procured was the M1928A1 Thompson gun. Even though the price of this model was eventually reduced to less than one-half of its prewar level, a simplification in design was effected in the M1 and the M1A1 Thompson gun in order to facilitate mass production and to reduce costs. These redesigns eliminated the compensator and the bolt-retarding lock since it was found that these items did not improve the military characteristics of the weapon. Furthemore, the separate firing pin was eliminated, and the firing pin was designed as an integral part of the bolt. Subsequently, the *M3 submachine gun* was designed to meet the requirements for a light and compact submachine weapon particularly adapted for use by paratroopers and one that could be manufactured without an increase in critical machine-tool facilities. The design of this model made it possible to make maximum use of excess available capacity in stamping and welding facilities.

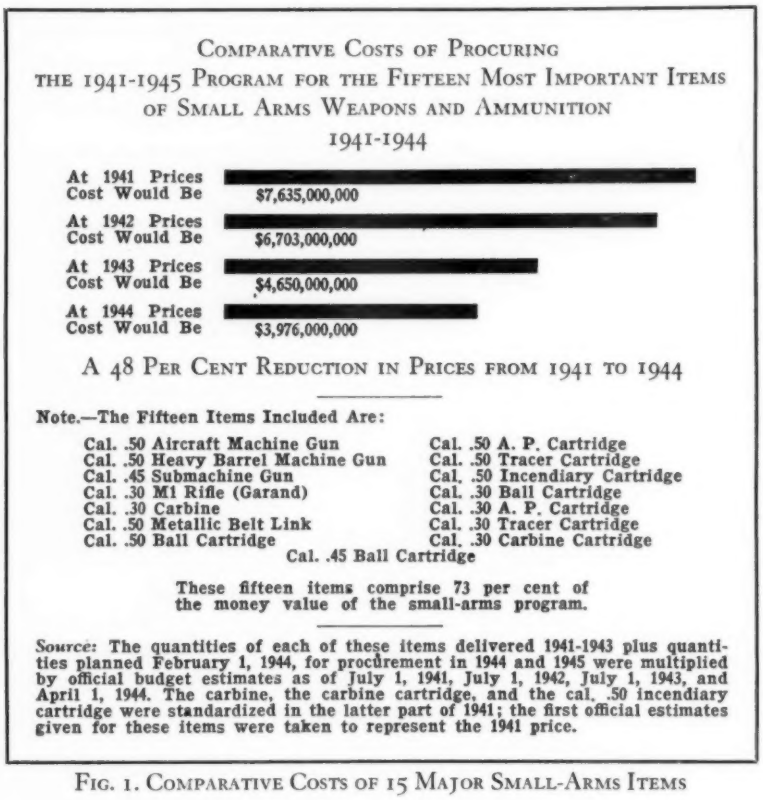
Comparative Costs of Procuring
the 1941-1945 Program for the Fifteen Most Important Items
of Small Arms Weapons and Ammunition
1941-1944
At 1941 Prices Cost Would Be
$7,635,000,000
At 1942 Prices Cost Would Be
$6,703,000,000
At 1943 Prices Cost Would Be
$4,650,000,000
At 1944 Prices Cost Would Be
$3,976,000,000
A 48 Per Cent Reduction in Prices from 1941 to 1944
Note.—The Fifteen Items Included Are:
Cal. .50 Aircraft Machine Gun
Cal. .50 Heavy Barrel Machine Gun
Cal. .45 Submachine Gun
Cal. .30 M1 Rifle (Garand)
Cal. .30 Carbine
Cal. .50 Metallic Belt Link
Cal. .50 Ball Cartridge
Cal. .50 A. P. Cartridge
Cal. .50 Tracer Cartridge
Cal. .50 Incendiary Cartridge
Cal. .30 Ball Cartridge
Cal. .30 A. P. Cartridge
Cal. .30 Tracer Cartridge
Cal. .30 Carbine Cartridge
Cal. .45 Ball Cartridge
These fifteen items comprise 73 per cent of the money value of the small-arms program.
Source: The quantities of each of these items delivered 1941-1943 plus quantities planned February 1, 1944, for procurement in 1944 and 1945 were multiplied by official budget estimates as of July 1, 1941, July 1, 1942, July 1, 1943, and April 1, 1944. The carbine, the carbine cartridge, and the cal. .50 incendiary cartridge were standardized in the latter part of 1941; the first official estimates given for these items were taken to represent the 1941 price.

Fig. 1. Comparative Costs of 15 Major Small-Arms Items

THE *M1 caliber .30 semiautomatic rifle* was standardized and was in production before war emergency. The major producer of this weapon has been Springfield Armory. The initial production cost of the rifle at the armory was $115 in 1938, but by 1941 this cost had been substantially reduced. Since 1941, the armory's cost has continued to decline sharply as the rate of production increased. The commercial price of this weapon has also been substantially reduced since 1941.

The reduction in the armory cost, and also in the commercial price, is a result of savings in man-hours required to produce the weapon. As is the case with practically all small-arms weapons, the cost of basic raw material is relatively small. The savings in costs and in man-hours have resulted not only from economies inherent in volume production but also from radically improved machine tools and method of fabrication such as broaching, mass use of form tools, and radically improved process and inspection gages. The savings in direct labor hours required at Springfield Armory are indicated in Fig. 3.

The *M1 caliber .30 carbine* was designed and standardized in late 1941 and contracts were placed shortly thereafter with two facilities. Unlike the M1 rifle, this weapon had not been fully developed, produced, or tested in the field prior to the war. As a consequence, many engineering changes have had to be made during the course of its production in order to accommodate both production and combat requirements.

In the latter part of 1942 there developed a need for the production of a greatly increased quantity of carbines in the the shortest possible time to meet combat requirements. This enormously increased demand came at a time when there was a shortage of machine tools and tool-making facilities. Delays in getting new tools and the necessary modification of such existing tools as were available, both in the plants of the prime contractors and of their subcontractors, greatly increased initial production costs for the new facilities brought into production of this weapon. These factors account for the increase in cost between July 1942 and July 1943.

The production job which was accomplished during 1943, despite the unfavorable conditions therefor, can be understood by the record of increases in the monthly production rate from a total of 48,000 for January 1943, to 179,000 in June 1943, and to 530,000 in November 1943. The total production for 1943 was over twenty-five times that for 1942. The higher cost experienced during 1943 may be looked upon as a reasonable premium paid for the remarkable production job done to meet the urgent combat need in the time allotted.

The greatly decreased production requirements for the carbine experienced in the early part of 1944 came at a time when most of the newer facilities had just begun to realize rapidly decreasing costs. The necessary vertical cutback of facilities, and the retention of only the two original producers with their relatively lower costs, are responsible for the much lower average cost shown as of April 1944.

THERE is also more to the story of the *caliber .50 metallic belt link* price than meets the eye in the chart. It should be noted first that basic raw material cost is almost one-half the total cost of this item, and the opportunity for cost reduction with increasing volume and improved methods is not as great as in the case with weapons.

The decline in price from July 1941 to July 1942 was experienced despite some very vexing die design and die-maintenance problems encountered by the facilities which were in production in the initial stages of the program. Subsequently it was necessary, in view of the increasing need, to bring in additional facilities until there was a total of twenty-two producing this item in 1943. This bringing in of new facilities with their high initial costs retarded whatever further decline in average price might otherwise have occurred. In the latter part of 1943 and early 1944, two factors affecting the over-all price for this item took place: (1) A change in

specifications requiring heavier gauge steel and more elaborate overseas packaging; (2) Two drastic declines in production requirements which necessitated, first, a vertical cutback and, subsequently, a horizontal cutback of the remaining facilities to the equivalent of a one-shift basis of operation, with the requirement that reserve capacity be maintained by the use of all equipment on such one-shift basis. In view of these conditions, it is remarkable that there could be a further slight lowering of price as of April 1944.

The decrease in costs of small-arms ammunition reflects, for the most part, the decrease in costs experienced at Government-owned contractor-operated plants. Since 1942, production at Government-owned plants has constituted ninety per cent of the total production of small-arms ammunition. The remaining ten per cent has been produced at privately owned plants, and, although decreases have occurred in their prices, these have had a relatively minor influence on the composite averages.

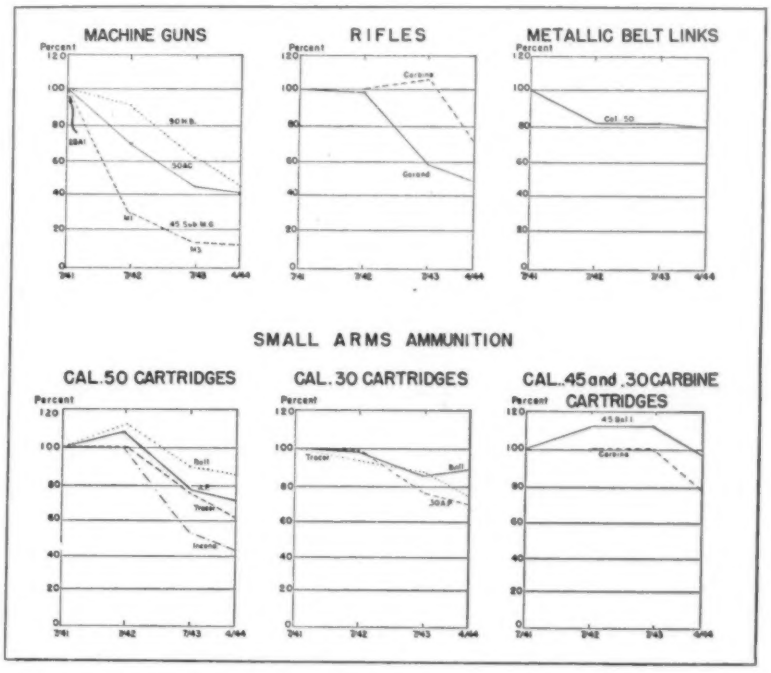

FIG. 2. RELATIVE PRICE CHANGES IN 15 SMALL-ARMS WEAPONS AND AMMUNITION ITEMS, JULY 1941 TO APRIL 1944

For comparison, the percentage relatives above are in terms of the following units: Weapons—basic gun only; Links—cost per thousand packed; Ammunition—cost per thousand, carton-packed.

The program of small-arms ammunition-plant expansion was conceived at Frankford Arsenal prior to the prewar emergency, and the plans for such expansion were in form for execution at the time France fell in 1940. These plans called for the construction of new Government-owned plants for the manufacture of small-arms ammunition on a mass-production basis. These new plants were equipped with special-purpose automatic machinery which had been designed by the arsenal and used in peak production there during 1939 and 1940. The layout of the plants was such as to maximize efficient flow of products and to minimize the dangers inherent in handling combustible materials.

The construction of these plants was initiated in 1940. Eventually, thirteen such plants were brought into production. In the latter part of 1943 and early 1944, decreased production requirements made necessary vertical cutbacks with the result that currently only five such plants are retained in production. In the five plants retained, a reserve is maintained through operation at about one-half capacity rates.

The decreases in costs experienced at Government-owned plants are a result primarily of more efficient utilization of man power. The cost of raw material used varies, according to the caliber and type of cartridge, from thirty per cent to fifty per cent of total current costs. While there have been some reductions in the costs of raw material, particularly cores, these reductions in material costs have affected overall costs to a considerably lesser degree than the savings realized in labor costs. Substantial savings have also been realized in the cost of perishable tools as a result of improvement in quality which has prolonged the life of the tools, reduction in the price of the tools, and better care being given the tools as plant personnel became trained in their use. For example, the cost of tools required to make caliber .30 cases has decreased from $4.50 to $1.25 per thousand cases. Although savings in tool costs have been remarkable, it is nevertheless the more efficient utilization of man power which accounts for the greater portion of the over-all decreases in costs experienced.

The savings which have been realized in labor costs are indicated in Fig. 4. This chart indicates, from July 1942 to January 1944, a saving of over forty per cent in man power required to produce the same amount of ammunition.

As has been indicated, the savings in man-hours at Government-owned plants fairly well explain the course of prices of small-arms ammunition. The July 1941 and July 1942 figures in the price charts reflect, for the most part, high initial costs experienced at the Government-owned plants. As the "trainee" program was completed and production reached the levels for which the plants were designed, substantial declines in costs took place. This is reflected in much lower costs shown as of July 1943. With the exception of caliber .30 ball, this downward trend has persisted to April 1944. The slight upward trend of caliber .30 ball as of April 1944 is a statistical result occasioned by a shift in the proportion produced at privately owned plants and that produced at Government-owned plants.

THE course of prices for the caliber .45 ball cartridge requires a brief explanation. Because of critical shortages of brass, a change-over to steel for the manufacture of this cartridge was made in 1942. Initial higher costs were experienced in this change-over to steel. However, the efficiencies realized through volume production of the steel cartridge case at a Government-owned plant brought the cost of the steel case to less than the prewar cost of the brass cartridge.

It will be observed generally by a review of the charts on the fifteen items that the bulk of the decline in costs for the group as a whole has occurred since July 1942. As a matter of fact, most of the decline has been realized since late 1942. The one salient conclusion which may be reached is that, despite all the conditions under which these items have had to be produced during the course of a war emergency, there

have been substantial reductions in manufacturing costs and prices, not only during the build-up to peak volumes but also after such peaks were reached. Reductions in costs and prices have been outstanding for those items produced pursuant to prewar planning.

For most of the fifteen items we are now entering a period during which production in the plants retained will be at a level considerably less than plant capacities. The future trend in costs and prices of small-arms matériel will depend in large part upon (1) the course of future production needs; (2) the manner in which readjustments, vertical or horizontal, are adopted to meet these changing needs; and (3) a continuation of efforts toward improved manufacturing techniques and cost reductions on the part of individual producers of small-arms matériel, no matter what limiting conditions may be imposed.

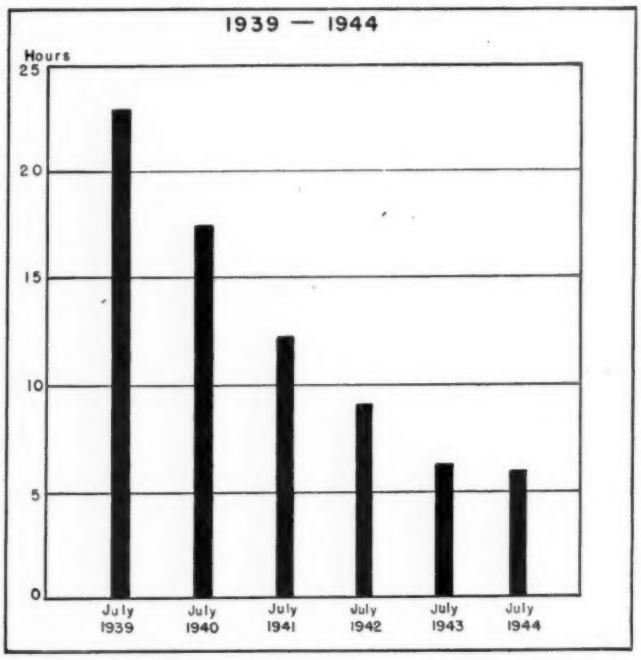

Fig. 3. Direct Labor Hours Required To Produce the M1 Rifle at Springfield Armory, 1939-1944

The pricing methods adopted for small-arms weapons and ammunition have been directed at two distinct types of problems: (1) The control of costs at Government-owned contractor-operated small-arms ammunition plants, the cost-plus-a-fixed-fee contracts for which are administered directly by the Small Arms Branch; (2) the negotiation by Ordnance district offices of "right" prices for small-arms weapons, small-arms ammunition components, and small-arms ammunition produced at privately owned plants. All district-administered small-arms contracts, except ten, are on a fixed-price basis. Of the ten district-administered cost-plus-fixed-fee contracts, three are being terminated or placed on a "stand-by" basis. As a preface to the discussion of the particular pricing methods adopted for these two distinct types of problems, it is well to state some general, if fairly obvious, principles within which such particular pricing methods must operate.

Particular pricing methods for war matériel must accommodate themselves to the existing commercial structure, even though during the course of the war emergency that structure has been somewhat cut loose from its usual regulator in the form of the competitive factor. In the place of this normal competition, reliance has been and must continue to be placed upon the efforts of individual contractors to reduce costs to the extent possible under all the conditions under which they must operate individually. This is the responsibility of each individual contractor, and, in the absence of the competitive factor, the standard of accomplishment for the individual producer is not how his costs compare with others—who very likely are operating under different conditions—but how his costs compare with what they ought to be for him under his particular operating conditions.

The corollaries in terms of price are (1) that where the competitive factor can be invoked, as in the case of vertical cutbacks, it should be invoked to determine price, and (2) that, in the absence of the competitive factor, the price ought to be one in line with the costs of the individual producer—not necessarily as they have actually been experienced but as future costs ought to be for him.

In the latter part of 1942, a survey was made of the costs of producing small-arms ammunition at Government-owned contractor-operated plants. As a result of this survey, uniform cost-accounting procedures were made effective January 1, 1943, providing for: (1) Costing Government free-issued materials (ninety per cent of raw material used) at uniform prices established by the branch; (2) Placing emphasis upon accounting for the physical quantities of raw materials used per thousand rounds of finished ammunition; (3) Segregating costs of packing (cartons, clips, links, web belts, etc.) from costs of manufacturing; (4) Uniform monthly reporting of costs for the plant as a whole and, in terms of unit costs per thousand rounds, for the different calibers and types. The general purpose of the uniform cost-accounting procedures established was to provide a reliable basis for controlling costs through intraplant and interplant comparisons.

In addition to the uniform monthly cost report, a correlated report on significant monthly operating statistics was devised. One of the main features of this latter report provided for a measure of relative utilization of man power by a comparison of total man-hours and total plant personnel with "production units" produced. The "production unit" is the production equivalent to one million rounds of caliber .30 ball cartridges, carton-packed. The factors by which these equated production units were initially determined were those used in the cost survey of October 1942, which were based upon the typical relationships between direct labor costs of each of the various types and calibers produced in each plant. Subsequently, as the result of an excellent study of standard labor hours prepared by the Small Arms Ammunition Industry Integrating Committee, more refined factors were developed and adopted.

The effective use and refinement of these tools by the various contractors and their effective administration by the Small Arms Ammunition Suboffice, culminated in the incorporation in July 1943 of an incentive-fee clause in each of the cost-plus-a-fixed-fee contracts for small-arms ammunition. This incentive-fee clause provided for semiannual adjustment of fees based not only upon such considerations as quality of product, volume of production, etc., but specifically upon: (a) The contractor's operating costs (comparison of his own costs from month to month and with costs of other plants); (b) The extent to which the contractor effectively utilized man power in the operation of the

plant. The results which have been realized, both in cost reduction and in more effective utilization of man power, speak for themselves.

The pricing methods adopted to assure the negotiation of "right" prices for small-arms items have, because of type of contract and of Ordnance organization, proceeded along different lines than those adopted for the control of costs at Government-owned small-arms ammunition plants. The approach to the two types of problems has, however, been identical in conformance to the basic objective of striving for a "cost to the Government" in line with "costs as they ought to be," irrespective of whether the contract is on a cost-plus-a-fixed-fee basis or on a fixed-price basis. For the few District-administered small-arms contracts on a cost-plus-a-fixed-fee basis, the methods of cost control followed are similar to those heretofore described for Government-owned small-arms ammunition plants.

Ordnance price analysis has been directed toward furnishing negotiators in Ordnance district offices with cost and price data which will be helpful in negotiation of "right" prices. Thus, price analysis is an integral part of Ordnance procurement. The methods by which practicable minimum costs are indicated for individual producers are outlined in "Pricing in War Contracts," a manual published in August 1943 by the Director of the Purchases Division, Headquarters, Army Service Forces.

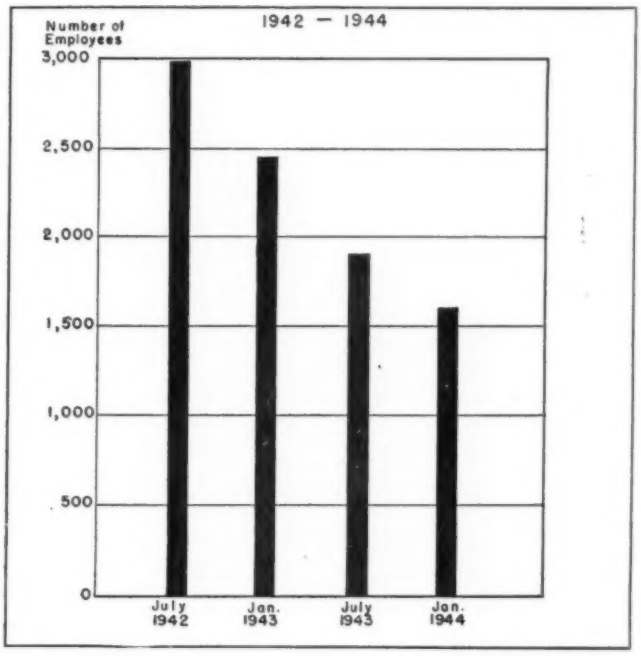

FIG. 4. EMPLOYEES REQUIRED IN ONE DAY TO PRODUCE IN GOVERNMENT-OWNED SMALL-ARMS AMMUNITION PLANTS A MILLION CALIBER .30 BALL CARTRIDGES OR EQUIVALENT

THE methods used in small-arms price-analysis work fall under three general categories: (1) An analysis of experienced and prospective costs and prices of the individual producer; (2) A comparison of experienced and prospective costs and prices of all producers of the same or a similar item; (3) A determination of practicable minimum costs for an item from a production engineering viewpoint. Because of the great variety of items handled and the various conditions under which they are produced, no set formula or method is used. Much depends upon the type and amount of cost and price information available and upon the ingenuity of the individual price analyst in making the available information go a long way.

The analysis of experienced and prospective costs and prices for the individual producer is the responsibility of small-arms district price analysts. One of the early conclusions reached in the small-arms price-analysis program was that the usual cost breakdown according to raw material, direct labor, indirect factory cost, etc., did not lend itself to a satisfactory analysis of costs and prices of assembly items such as small-arms weapons. Variations in the degree of subcontracting of components rendered difficult a comparison with past costs of the same producer as well as with costs of other producers. Moreover, cost figures for material, labor, etc., for the end item as an entity obscured rather than defined the specific points at which costs were out of line. Accordingly, for small-arms weapons a program was initiated to seek the manufacturers' coöperation in furnishing detailed cost data by components, together with a correlated listing of individual subcontract prices for those components subcontracted.

This program has been mutually helpful in localizing out-of-line costs or subcontract prices by comparisons made by Ordnance with similar data furnished by other producers of the same or a similar item. In addition to such "component analysis," particular consideration has been given also to determining on the basis of chronological costs the current and prospective position of the individual producer in the "cost curve," —the "cost curve" referring to the normal and expected tendency of costs to decline with increasing volume and additional experience of the producer's personnel in manufacturing a new production item.

The comparison of cost and price of all producers of the same or a similar item is primarily a function of the manufacturing branch and is performed as an aid in indicating to district price analysts and negotiators the minimum practicable cost for each individual producer. Such comparative cost and price studies must necessarily be based upon cost-and-price data of the various producers as supplied by district price analysts and upon such other pertinent information as is available from other sources. Of great value in the latter respect are production and engineering data available within the branch.

The most important of the formal comparative studies made for small-arms items was that for the caliber .50 aircraft machine gun prepared in September 1943. This study pointed up (1) the importance of considering the producer's relative cost experience to date in determining his present and prospective position in the "cost curve," (2) the effect on costs of the type and condition of tooling and equipment, (3) the effect on costs of "spread-the-work" subcontracting, (4) the effect of different types of manufacturing methods both on the number of total labor hours required per unit produced and on the average labor rate paid, (5) the unreliability of geographical *basic* wage differentials in indicating differentials in labor costs of different producers, and (6) the effect on costs of overtime and other wage premiums. Most significant of all, the study indicated the adverse effect on costs of effective hourly labor rates paid in areas of critical labor shortages. These conclusions and others reached in this study of the caliber .50 aircraft machine gun have furnished a perspective for both formal and informal analyses for other small-arms items.

Enemy Oil

The Collection and Analysis of Captured Petroleum Supplies

Capt. N. L. Klein

STRETCHING from the heart of the "Arsenal of Democracy" to almost every corner of the globe are the huge arteries of supply upon which our fighting forces depend for the materials of war. Well over half of the total supplies flowing through these arteries are petroleum products, the lifeblood of the modern Army. The never-ending search for better petroleum products to meet the requirements of extreme climatic and operational conditions goes on, but what of the quality and quantity of enemy lubricants?

To ascertain the enemy's ever-changing oil position is like putting together a jigsaw puzzle in which the various pieces which make up the over-all picture individually change shape from time to time. Technological improvements result in some changes in enemy fuels and lubricants, but more often sheer necessity due to a shortage of crude oil, the loss of refinery capacity, or transportation difficulties, force changes to be made. It can truly be said that the enemy's ability to wage war at any time bears a direct relationship to his oil position.

The Ordnance Department early realized the importance of obtaining and utilizing detailed information on enemy ordnance in order to maintain at all times the superiority of the combat equipment supplied to our troops. Petroleum products are essential to Ordnance, for without them it cannot operate at all. There are four basic reasons for studying the enemy's fuels and lubricants: (1) to determine what use can be made of captured petroleum products in U. S. equipment in order to augment our supplies during rapid or sustained advances, or when for other reasons the flow of our own supplies is restricted; (2) to uncover the use of synthetic and substitute materials and methods of formulation which may be helpful to our industry; (3) to ascertain the sources of the crude oil and methods of refining; (4) to disclose changes in the products and shortages of supplies.

The framework of the organization engaged in the overall study of enemy ordnance has been described by Col. Scott B. Ritchie, chief of the Research and Materials Branch, Ordnance Technical Division, in the July-August 1943 issue of Army Ordnance and will not be repeated here. However, it may be well to examine the organization engaged in the investigation of the petroleum phase of enemy ordnance more in detail to appreciate the work being done. All work on enemy fuels and lubricants is directed and coördinated by the chief of the fuels and lubricants section of the Research and Materials Branch.

The fuels and lubricants section is charged with responsibility for the initiation, supervision, and coördination of all research and development activities for all Army (except aircraft) fuels, lubricants, recoil and hydraulic fluids, rust-preventive and cleaning and preserving materials, and for the development of specifications covering these materials. The study of enemy fuels and lubricants is of paramount importance when viewed in respect to the development work currently being done on our own products. The fuels and lubricants section analyzes military and naval attaché and Enemy Oil Committee reports on enemy petroleum products as well as other reports of interest from various other agencies.

Analyses of enemy products are studied, translated into American terms, and the products classified according to type and grade. Approximately 1,000 analyses have been handled in this manner to date, and a summary has been made which is in effect a set of enemy fuel and lubricant specifications. The summary has been distributed to those theater Ordnance officers whose responsibility it is to make field recommendations concerning the use of enemy materials in U. S. equipment and to the mobile laboratories which make routine inspection analyses in the fighting zones.

Samples of enemy fuels and lubricants are collected by Ordnance intelligence units on all fighting fronts and are forwarded, usually by air transport, to the Foreign Matériel Branch at Aberdeen Proving Ground where they are catalogued and shipped to various industrial laboratories coöperating with the Ordnance Department through the Coördinating Research Council. The Ordnance Department realized the difficulty and magnitude of the task at hand and requested the Coördinating Research Council to assist in the analysis of samples and interpretation of data. In this manner, the technical skill, knowledge, experience, and facilities of the American Petroleum Industry are brought to focus upon the enemy's oil position.

UNDER the Coördinating Research Council—a coöperative petroleum industry group sponsored by the Society of Automotive Engineers and the American Petroleum Institute—six analysis panels were formed among laboratories especially efficient and experienced in the analysis of gasoline, Diesel fuel, engine oil, grease, gear oil, and special products. Detailed analytical studies are made by these panels which give recommendations concerning the use of captured fuels and lubricants in U. S. equipment. The analytical data obtained by the various laboratories is next studied by an advisory group composed of experts on the subject of foreign petroleum production and refining who formulate opinions concerning the source of the crude oil and methods of refining. The Coördinating Research Council then makes a complete report on each group of samples to the fuels and lubricants section which studies these data in the light of information received from other sources and disseminates the complete information to all interested offices.

In this manner, a complete analysis carried out in such detail as to break products down into their component parts, supplemented by the interpretation and advice of experts in the petroleum industry, gives to the Ordnance Department in a relatively short period of time the same information available to the enemy as a result of years of reseach. Using this information, the Ordnance Department can continue to control the high quality and insure the superiority of our own materials even though forced to rewrite existing specifications as a result of shortages of critical materials. In addi-

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tion, the engineering studies being conducted on captured equipment can be furthered by detailed information concerning the petroleum products it was designed to use.

Many samples of the same product must be investigated before the physical and chemical properties of the material and the refining limits allowed can be specifically identified. The fuels and lubricants section synchronizes the work of the Coördinating Research Council analysis group with that of other agencies in order to prevent a duplication of effort. Once an enemy fuel or lubricant has been positively identified, no further analytical work is done on the material other than periodic inspections which are required to indicate changes in quality or formulation or other such trends in the enemy's oil position.

THE high standard and uniformity of German petroleum products is noteworthy. Their supply system has functioned efficiently, and their petroleum products are delivered in good condition and in adequate containers which have been carefully and accurately marked. However, the conclusion can be drawn, based on the analyses of samples from the field, that the German oil economy has been strained to the point where the enemy has had to juggle crude sources and refining methods; nevertheless, it is evident that specifications are rigidly adhered to. In many instances, there is evidence of standardization and simplification of type and grade similar to that which we have been able to accomplish for our own petroleum products. It is interesting to note that the Germans seem to make a regular practice of blending materials in the field. This does not apply to their lubricating oils and greases or to their fighter-grade aviation fuel.

Tetraethyl lead, benzol, and, in some cases, alcohol are blended to motor-transport gasoline base stocks at supply dumps in the theaters where they are to be used. There is also some evidence to indicate their B-4 bomber-grade aviation fuel is handled in the same way. Such practice requires portable tetraethyl lead blending equipment and many trained technicians.

German aviation fuels, of which there are two types—a green fuel known as C-3 fighter grade and a blue fuel known as B-4 bomber grade—are of particular interest. The C-3 gasoline has an octane number of 99, motor method, and a rich-mixture rating of S + 3 (100-octane fuel plus 3 cubic centimeters of tetraethyl lead). The rich-mixture rating is the outstanding feature of the C-3 fuel and is the result of an unusually high content of aromatic fractions over a boiling range which includes benzene, toluene, ethylbenzene, xylenes, and higher aromatics. The C-3 fuel contains approximately 4.5 cubic centimeters of tetraethyl lead per gallon and is comparable to our 130-grade fuel. The B-4 fuel has an octane number of 93, motor method, and contains approximately 3.25 to 3.90 cubic centimeters of tetraethyl lead per gallon. It is comparable to our 91-grade fuel.

Over a period of time, many samples of motor-transport gasolines of varying characteristics have been examined. More recently, however, it has become apparent that the Germans are making an effort to standardize on two grades of motor-transport fuel, a 70- to 72-octane-number fuel marked "2" and a 77-octane-number fuel marked "1". Fuel "2" is made by adding tetraethyl lead in the field in sufficient quantity to base stocks of varying octane numbers to raise the octane number to 70-72. Fuel "1" appears to consist of Fuel "2" to which benzol has been added in the proportion of two to one.

The general characteristics of German aircraft engine oils and the high quality standards which are maintained are also of particular interest. Earlier samples of these products were found to contain Voltolized vegetable oils and these oils were used interchangeably with solvent-refined straight mineral oils. Recent samples are of two general types: a straight mineral oil and blends of synthetic bright stock and mineral oil. Several aircraft-engine oils which are apparently in general use by the *Luftwaffe* are described below:

Flug Schmeerstoff Rotring.—This is an S.A.E. 60-grade, high-viscosity-index (106 V.I.) lubricating oil resembling a blend of a high-quality mineral oil with an oil of synthetic origin.

Rotring L-45.—An S.A.E. 60-grade, with properties practically identical to Flug Schmeerstoff Rotring.

Flug Motorenoel Rotring.—An S.A.E. 50-grade, high-viscosity-index (99 V.I.) lubricating oil consisting of a blend of a good-quality mineral oil and an oil of synthetic origin.

Rotring.—An S.A.E. 50-grade, high-viscosity-index (92 V.I.) straight mineral oil, possibly solvent-processed from Mid-Continent-type crude. Oils of this type may represent materials purchased from this country before the war.

The *Wehrmacht* uses three grades of automotive-engine oils in ground-force equipment. For the most part these are high-viscosity-index oils of good quality derived from solvent-extracted stocks from German crudes. Oils which may represent prewar purchases are also used. Most recent samples indicate that synthetic oils are also being supplied to ground forces. Several automotive-engine oils in general use by the German Army are described below:

Motoren Einheitsoel.—An S.A.E. 30-grade, solvent-refined straight mineral lubricating oil of relatively high viscosity index (89 V.I.) refined from German crude oil. It is intended for use in summer and winter in a wide range of engines.

Motoren Einheitsoel der Wehrmacht.—An S.A.E. 30-grade, high-viscosity-index (100 V.I.) lubricating oil containing 2.5 per cent fatty oil. The content of fatty oil indicates that this product is probably Voltol oil, with the possible addition of a viscosity-index improver.

Sonder Motorenoel-T.—An S.A.E. 40-grade, mineral lubricating oil of high viscosity index (103 V.I.) and good quality. The high viscosity index has been accomplished through the addition of a viscosity-index improver.

Motorenoel.—This is an S.A.E. 50-grade engine lubricating oil of high viscosity index (99 V.I.) and of a synthetic origin possibly made by polymerization of cracked hydrocarbons. The material contains a viscosity-index improver similar to Paratone.

GEAR oils used by the German Army are of three general types. Certain of these oils contain fatty oil additives but the additive materials are not of the extreme pressure type in general use in our own gear oils. All the German gear oils investigated have been of medium viscosity index and are probably derived from Rumanian crudes. The three general types of gear oils used by the *Wehrmacht* are described below:

Getrieboel 18, PPH-18, and *J-18.*—These are S.A.E. 90-grade transmission oils having a very low content of saponifiable material indicating the presence of additives of the viscosity-index-improver type.

Getrieboel Wifo.—This gear oil is of a lower viscosity but similar in all other respects to the products mentioned above.

Getrieboel Vario Rex.—A heavy gear oil containing bitumen and approximately five per cent fatty oil of marine animal origin.

Information on two types of lubricating greases used by the *Wehrmacht*—namely, Einheitsfett, or standard grease for all vehicles, and Wasserpumpenfett, water-pump grease—is given below:

Einheitsfett.—A soda-soap-base grease made with a low-viscosity naphthenic mineral oil. The product appears to be grainy and lumpy in character, indicating poor manufacture. An unusual feature of this grease, based on American standards, is its high content of a waxy material of undetermined origin which is evidently added to reduce the percentage of fat required.

Wasserpumpenfett.—This is a calcium-soap-base grease made with a low-viscosity naphthenic oil. The quality of this material appears to be high, indicating experienced manufacture. The grease is in no way unusual or unique when compared with greases manufactured in this country.

A large variety of German Diesel fuels also has been examined. Attempts have been made to classify the different inspections into groups of high- and low-speed Diesel fuels. Most of the samples indicate a high degree of refining despite the fact that they are evidently derived from a number of different sources. Several samples of low-pour-point (—40° F.) Diesel fuels have been investigated. The low pour point indicates extensive dewaxing; however, there is little suggestion of climatic segregation since low-pour-point fuels were used by the Germans during the Libyan campaign.

There is nothing unusual about German recoil fluids. It seems to be standard German practice to use the same recoil fluids for all classes of artillery. The standard fluid was known as Bremsflussigreit Braun (brown buffer fluid). For low-temperature operation this was superseded by Bremsflussigreit Braun-Arr which consists of equal parts of "brown fluid" and another fluid known as Bremsflussigreit Ark Tisch (arctic fluid). These fluids appear essentially to be mixtures of triethylene glycol and water.

Our study of German petroleum products indicates that they may be largely refined from crude oils obtained from the fields of Rumania, Hanover, Reitbrook, Vienna Basin, Poland, and Hungary with smaller production from the fields of Albania, France, the Ukraine, and Czechoslovakia. Large quantities of synthetic materials may also be obtained by the Bergius and Fischer-Tropsch processes and from the hydrogenation of coal tars to supplement the production of natural crudes. In addition, the use of vegetable and reclaimed oils, the latter being used extensively in home industry, play a part in the German oil economy.

THE study of captured German fuels and lubricants demands a consideration of methods for the production of synthetic substitutes for petroleum products. There are two well-known processes: the Fischer-Tropsch gas synthesis process and the Bergius hydrogenation process. The Fischer-Tropsch process provides a method for the production of gasoline, gas oil, and paraffin wax from bituminous coal or coke. Briefly, the process consists of first producing carbon monoxide and hydrogen in a water-gas generator and then passing this mixture of gases over a catalyst in a specially constructed converting oven. The resultant products are a mixture of paraffinic hydrocarbons ranging from the light gases through solid wax. Gasoline and gas-oil fractions represent the major products, while bottled gas and lubricating oils derived from the wax form the remainder of the final product. The gasoline is of low-octane number and must be blended for use as motor gasoline. The high paraffinicity of Fischer-Tropsch stocks make them especially desirable as Diesel-engine fuels.

The Bergius or hydrogenation process starts with brown coal or lignite which is dried, cleaned, crushed, and mixed with heavy oil to form a paste. An appropriate catalyst is added to the paste which is pumped together with hydrogen gas into a high-pressure vessel where the hydrogenation reaction takes place. Several stages, or successive reactions are required to complete the conversion, each stage producing more gasoline and a mixture of light and heavy oils. The light oil is repassed through the reactor as a vapor while the heavy oil is used with additional coal to form the paste for the first stage. This process yields a gasoline of good quality suitable for use as motor gasoline and may even be blended in aviation gasoline. Variations in the hydrogenation process employ low-temperature tar and creosote oils as raw materials in the manufacture of gasoline.

Voltol oils, which have been mentioned in this article, are mineral, animal, or vegetable oils, or mixtures of these which have been polymerized by electric discharge under controlled conditions. The procedure employed in the electrical treatment of oils is substantially as follows: The oil is allowed to flow over rotating electrodes under a high-voltage, high-frequency electric current. The entire reaction is carried out under pressure in an atmosphere of hydrogen to prevent oxidation and results in great increases in viscosity of the reacted oils. The reacted and unreacted products may be separated by vacuum distillation. However, separation does not appear to be necessary for many lubricating-oil stocks.

IT can be seen that German plans for total war took into account a possible shortage of natural crude oils, and methods were devised to supplement supplies. Although petroleum products supplied to the German armed forces are strikingly different from those supplied our own forces, this does not imply that they are inadequate or of inferior quality. On the contrary, these products, used in equipment designed to operate on such materials, should, and apparently do, perform satisfactorily.

A similar study is being made of Japanese fuels and lubricants. Now that action has been joined with Japanese forces, Ordnance intelligence units on these fronts have shipped many samples of captured petroleum products to this country where they are being investigated. Close scrutiny and surveillance of the Japanese oil economy will be maintained and the Ordnance Department will furnish data essential to our troops for the proper use of Japanese materials.

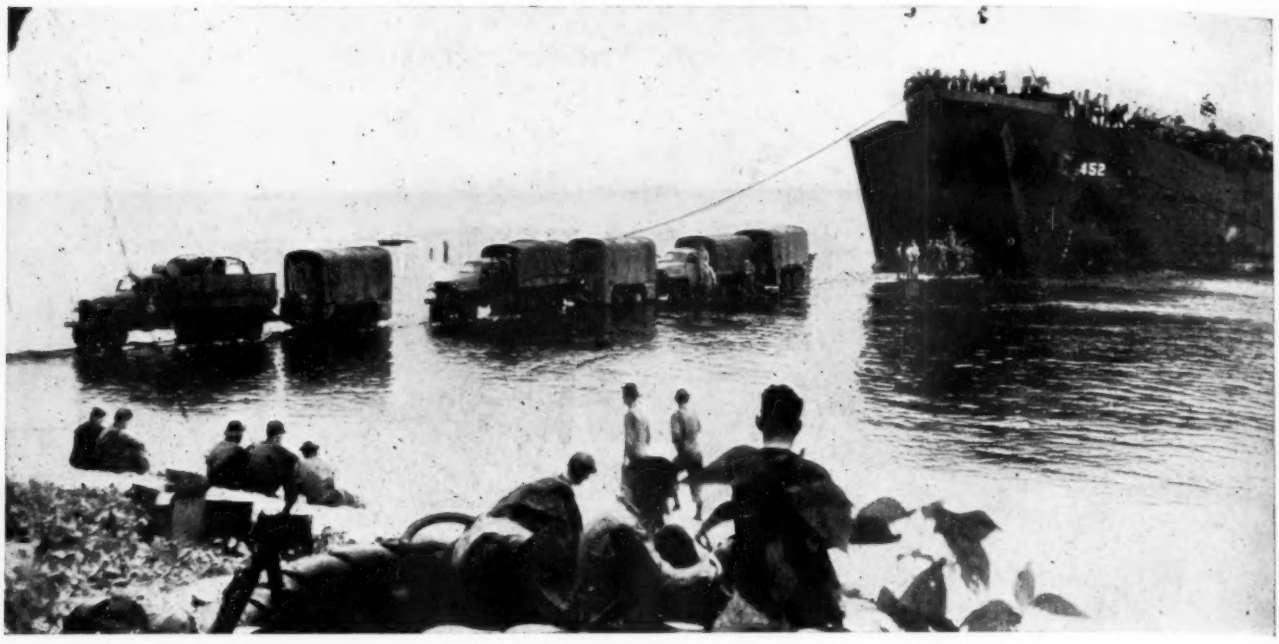
In conclusion, based on the analysis of samples of captured materials on all fighting fronts, it can be said that no decline in the quality or adequacy of enemy fuels and lubricants has been detected. The technical skill of the enemy has built a flexible petroleum structure in which synthetic and substitute materials play an important part. An efficient system of distribution of these products to their armed forces has been successfully maintained and administered by a technical organization in the field.

The Industry-Ordnance team, working in close coöperation with the Office of the Quartermaster General, the Foreign Economic Administration, the Enemy Oil Committee, and other interested services and agencies, will continue its close scrutiny of the enemy's fuels and lubricants so as to be in a position to use captured materials intelligently in our own equipment and to keep our development well in advance of anything the enemy may produce.

Our New 120-mm. Antiaircraft Gun

Ordnance Department

The Army's new 120-mm. (4.7-in.) "stratosphere" antiaircraft gun, above, fires a projectile 20,000 feet higher than any other known antiaircraft weapon. The gun uses separate-load ng ammunition, and the shell fuze is set automatically as it and the powder charge are rammed home mechanically. The gun travels on a mobile carriage and can be emplaced quickly.



Ordnance Overseas

Problems of Supply and Maintenance in the Theater of Operations

Col. G. K. Heiss

WHAT does a combat soldier take with him out of training when he is finally sent into the theater of operations? Is it anything transferred from the printed page onto his imprinted mind? Probably not much. Action habits that will stick with him when he comes up against the real thing? A few, plus certain basic principles which will enable him to improvise; in other words, to meet the situation as he finds it and to do a necessary job whether or not he finds all the desirable means or can use all the promulgated methods.

In the supply-and-maintenance part of soldiering in the theater of operations we do much the same thing. No supply officer or noncom ever long misunderstands this use of the word "theater"; he may think of himself as the "prop man," but he will not know what the play is to be, not at least beyond a couple of scenes, and he can seldom anticipate his cues.

So soldiers of Ordnance go overseas chock full of bulletins, circulars, and lists, and in short order find themselves improvising for all they are worth, just as they see others of the force do, and, for the record, just as glad as they of the trained habits on which their instinct and improvisation are based.

The relatively small amount of book learning and the trained habits of action from back home are indispensable to the ability to improvise, and all the experience of the men overseas emphasizes the importance of what is taught them before they leave and what is done for them afterward. Improvisation does not contradict established practices, but carries them further in the face of necessity.

Ordnance base practices overseas were changed from the established patterns, as indeed it was known they would be, by the fact that this was not an American industrial area, that supplies had already gone through battle when they reached the base, that transportation within the vast base area was difficult, and that the enemy determined the factor of time for each base action. Finally, some details of Ordnance service could no more be anticipated than could the details of combat.

The usual situation is something like this. A body of troops of a given kind is shipped to an area along with a given lot of equipment and replacements. The enemy, the terrain, the climate, and the fortunes of battle will determine the adequacy of equipment and the nature and scale of necessary replacements, but all these factors are yet untried. The exigencies of port loading disrupt the grouping of supplies; on the way across a few ships may be lost. When the convoy reaches the theater, troops will be docked where they can find port quickest, and their supplies will catapult in out of the submarine zones where there are docks open; these may not be the same or neighboring ports—several hundred miles may separate them. Replacements or earmarked supplies, too, will nose in where they can, and only later will their purpose and exact destination be considered. A base may thus be broken into as many parts as there are ports and not according to any distribution plan.

So the enemy under the sea can do this much at least: he can put our supplies through the disorder of battle before they ever reach the land fronts and see that sometimes our overseas base supply begins with virtual chaos.

If the stockage of a base section is scattered haphazardly among half a dozen port backup depots, the first necessity for the base is to find out what it has and where it is; the second is to move stocks as much as necessary but as little

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as possible; the third is to make educated guesses about future supply requirements as to kind, quantities, and time. The second and third must be accomplished without interruption of supply and maintenance to troops.

When the Ordnance section of Headquarters, Mediterranean Base Section, North African Theater of Operations, was activated on December 8, 1942, Ordnance supply had to be managed without record cards, bins, lift trucks, or other depot facilities. It possessed only what it had brought along with it or found in Axis-stripped North Africa and did not have time to wait until it could get more from the zone of interior.

Issue began as soon as the landing was made—and it is possible that it must sometimes begin even before landing. There were not two phases—one period of setting up depots followed by the period of operation; the depot had to carry on its mission of supply and establish itself at the same time. Maintenance likewise began immediately. Establishment of complete base facilities required eight months' work. This was a fertile period for invention.

Supplies were, of course, manhandled. If handling equipment could have been found on the scene, it would have been taken and used, but the quantity actually found was negligible. That failing, man power was used. Labor untrained for handling Ordnance types of matériel in such volume was in itself something of an improvisation, and almost every private Ordnance soldier found himself doubling as a foreman over a group of natives.

All considerations were secondary to the element of time. Paperwork, of course, was secondary to the vital necessity of getting a new trigger spring into a machine gun broken somewhere out on the desert. However, to protect the stores (and rationing was started immediately) it was essential even for preliminary operations that a system be set up to govern proper distribution. There were never sufficient stockages to give each unit everything it wanted. Requisitions were all edited. The basis for editing was ultimately common sense, and this, too, was a kind of improvisation.

THE standard-nomenclature lists and other publications and patterns brought along from the "old country" were not sound bases for editing requisitions received from organizations. Instead, editing was done on the basis of what was actually needed by a troop unit at the time in order to maintain its equipment and accomplish its mission, so allotments were based on organizational priorities established by command channels.

Requisitions were regularly received for matériel which appeared to be in excess of what was needed, so, according to priorities, judgment was exercised supported by investigation to find out what was really needed instead of taking the word of the requisitioning officer.

The earliest and most striking observation made in the Ordnance section was that there was no continuity of demand. Instead, demand fluctuated widely or even wildly. This, of course, depended on the action of the organizations being supplied. After a battle there would be a sudden demand for a great deal of equipment and replacement, but there was no way to tell just when such a period would recur, and a unit at rest might have no demands.

Thus guesswork, or more euphemistically, estimates, took the place of orderly prediction. Based on strategic information obtained through command channels, supply requirements were projected ahead some ninety days—the time it took to get replacements from the United States. These projections were largely independent of any printed prediction of consumption such as standard-nomenclature lists or their addenda.

SUPPLY demands had two phases: first, spare parts and cleaning and preserving materials had to be supplied to maintain equipment while it was being used—while a unit was in battle. In the other phase, out of battle, the unit's equipment had to be put quickly into good condition for the next action. In addition to these supplies, new equipment had to be ready to replace matériel destroyed in battle. Finally, the various maintenance organizations had to take over the equipment that had been in action and bring it into perfect condition for any contemplated future action.

Supply and maintenance were virtually inseparable in the theater: their peaks were identical and their successful accomplishments were interdependent. Supply is no respecter of echelons and, so close to combat, neither is maintenance. An organization will do as much as it possibly can to keep or put its equipment in action, regardless of the echeloned division of labor envisaged for them. To some extent, authorities and responsibilities, too, are improvised. Getting the job done in time governed all practices, subject to the trained habits in the back of the soldier's mind.

Particularly were supply and maintenance fused in the job of putting a troop unit on its wheels for a new campaign. For instance, a tank track with a quarter of its life left in it after the African campaign could not be sent into the campaign in Sicily. That track, with a quarter of its life remaining, although still functioning perfectly, had to be replaced with a new track. Similarly, a truck engine good for another two or three thousand miles, or a tank engine with another fifteen hours of life, even though not requiring major overhaul, could not be sent into Sicily but had to be replaced. Thus, in a sense, the African base as it matured took over functions that had earlier belonged to zone of the interior shops, ports, and staging areas.

In so fitting the units supplied by the Mediterranean Base Section for the Sicilian campaign, estimates were made in February and March as to spare parts and supplies which would be needed in June to do this sudden job all at one time. These supplies were ordered from the United States.

The refitting was done as each unit—division or part of a division—returned from the front and was placed by command channels in priority of overhaul or reëquipment for future action. After obtaining authority from the commanding general of the division through the Ordnance officer of the division or S-4 of smaller units, Ordnance personnel scheduled the units by company or battery to have their equipment one hundred per cent inspected by the qualified personnel from the base section. All the equipment this inspection disclosed could be used in another major campaign without major overhaul was given first- and second-echelon maintenance, either in the field or at one of the base's two Ordnance inspection centers. If third-, fourth-, or fifth-echelon work was required, the equipment was sent from the service center to the base shops where engines or other assemblies requiring extensive repairs were pulled out, replaced with a new or overhauled item, and put through base rebuild or repair and sent to the depot.

To meet schedules, the inspection of a division had to be

completed in ten days. This meant at times inspecting 400 vehicles a day, of which about half were found to require only first- and second-echelon work. Accordingly, the organization, shop, and replacement supply to which were sent the remaining 200 vehicles which required higher echelon repair, were geared to handle 200 vehicles a day. Of these, about 100 engines had to be rebuilt or given major repair, and the engine shop was accordingly scaled to this task. This approximation of demand was made the basis for the requisition of additional parts in February for use in June.

THE relation of the base depot to the troops was never as planned. Theoretically, it was a filler point for advance depots and Ordnance depot and maintenance companies with their mobile equipment. Actually, the depot also directly supplied even regimental combat teams—sometimes when they were brought back to the base and sometimes when supplies were shipped or flown to them. In effect, then, the base became an entire zone of communications, having the traditional base job and all the other zone of communication Ordnance functions added to it.

Signal Corps

REPAIRING A TANK TRACK IN THE THEATER OF OPERATIONS

This made the job much bigger than it looked on paper. Besides handling supplies in bulk, the base distributed even single pieces, issuing to units from regimental to corps size for maintenance from first to fifth echelon. And parts were never sufficient to build up a reserve or to fill all maintenance units. This distortion of the plans was due to the great stretch of more than 600 miles serviced by the base and to the fact that other Ordnance service troops, installations, and means were not available.

This distance, together with the necessity for clearing ports and moving and distributing cargo to proper locations, resulted in the operation of trucks and trailers during the frequent periods of stress for twenty-four hours a day. The result: Insufficient time for proper preventive mantenance and a demand for parts during a given period of time far in excess of that which would have been required for normal operation.

The base section was confronted by the practical necessity of keeping its task within bounds. It became a base function to see that not all maintenance was base maintenance—in other words, that organizational maintenance was enforced. It has always been obvious to Ordnance that preventive care and operation and operators' vigilance in servicing equipment and catching trouble in early stages would reduce the necessary rear-echelon maintenance more than proportionally.

Accordingly, Ordnance inspection detachments were sent into all the troop organizations in the base area to inspect both the vehicles and the records of their maintenance. Approaching the organization through command channels, an inspection team of an officer and two enlisted men would completely inspect ten per cent of the vehicles. If these were found to be unsatisfactory, the remaining ninety per cent were spot-checked, and the unit motor officer was instructed through command channels to have the equipment up to standard for an inspection within two weeks.

Commanding officers of higher echelons were informed of inaction or continuingly unsatisfactory conditions, with a reminder that failure to keep motor vehicles properly serviced and maintained results in shortening the life of the vehicle with increased loads on transportation and maintenance.

If, upon subsequent inspection, the discrepancies previously reported had not been corrected, all vehicles were put in first-class condition by Ordnance base personnel and the conditions reported through command channels for appropriate disciplinary action. Repeat visits were made to assure that the organization commander did not again neglect his equipment.

Road inspection was also practiced. The team would stop vehicles at random on the road and inspect them on the spot. Vehicles in good condition were given a dated sticker. Those not satisfactory were sent to the Ordnance service center, were properly serviced, and the commanding officer of the organization to which the vehicle belonged was advised through command channels of the unsatisfactory condition.

REASSEMBLY of partly disassembled motor vehicles was one step—the base section's—between manufacture and use on the battle fronts. Partial disassembly or TUP (twin-unit pack) was a compromise between shipping vehicles as they stand on their wheels, which would require huge ship tonnage, and shipping them CKD (completely knocked down), which would require complete assembly plants at destinations.

The compromise left the engine on the chassis which was otherwise completely stripped down. Two such stripped chassis were packed in one box; hence the "twin-unit pack." The other major assemblies of a vehicle—cab, body, axles, wheels, etc.—were likewise packed with their counterparts in one box. This type of pack resulted in the packing of two complete 2½-ton trucks in three boxes and a bundle and smaller vehicles in three boxes. The twin-unit pack saved a great deal of shipping space and required a less elaborate assembly plant, although many special tools, heavy-lift equipment, and trained personnel were necessary for reassembly.

Shortly after the invasion of Africa, TUP vehicles began to arrive at the base in quantity, and their assembly was urgent. The "necessary" tools, equipment, and personnel, however, did not arrive, as preference in the convoys from England was given to troops and mobile service units. Whereupon the necessary facilities became "unnecessary" by virtue of the fact that the job had to proceed without them.

Lacking the equipment designed for the task, the base immediately began an exhaustive search of the Oran area for substitutes. A hundred-odd twin-unit-packed trucks were already lying where they had been unloaded on mud flats behind the port, so the open ground where chance had left them became the location and the shop.

Heavy crane equipment to handle boxes up to 10,000 pounds would be necessary—and no lifting equipment was to be found except a few 4- and 10-ton wreckers. Heavy-duty trucks or tractor-trailers would be required to carry the boxed vehicles from the docks up the long steep hill into the city—until the mud lot became the assembly plant.

Specially trained mechanics and other skilled workmen in large numbers, together with special tools, were essential—but instead the job was undertaken by an Ordnance company (HM-Q), energetic but untrained in vehicle assembly, with no equipment but the maintenance equipment of the company which was not designed nor intended for use in production-line assembly of vehicles. So a vehicle assembly line, intricate flowering of machine civilization, sprang up in the North African mud under the open dripping and later blazing sky, made of the muscle and imagination of 5 officers and 276 men. In seven weeks, day and night, more than a thousand vehicles were assembled and delivered to the ground troops, and *at the same time* the plant with which to do it was put together, improvised, and completed.

Signal Corps

AN ORDNANCE MAINTENANCE CREW OVERHAULS A 155-MM. HOWITZER

IN those seven weeks, assembly routine was taught in three languages and mimicry. A complete plant drainage system was built, for it was the rainy season. The vehicle first on the line became the tractive force to pull succeeding vehicles through. A damaged chassis with an engine, two winches, and scrap steel made a crane; scrap-metal framework with engine-driven winch fed the feed line. A truck engine powered the secondhand generator (which had been overlooked by our Axis predecessors) and charged 160 batteries at a time. Mobile lighting and welding units were improvised from old vehicles. Finally some cover was raised and an electric hoist "requisitioned" from an Oran shop.

A few further difficulties were imported: the knockdown wood bodies which only sometimes fitted the chassis; the fixed wheel studs and nuts which might well have been left off to effect saving of time and labor. But not one serious defect in the vehicles assembled slipped through this improvised assembly plant and its inspectors. After several months, and after having assembled more than twenty thousand vehicles, the plant functioned most efficiently.

In ammunition storage, cover was no problem—there was none. Some camouflage protection against enemy aircraft was found in olive groves and through pyramid stacking, which throws comparatively little shadow. Protection against fire was easiest where underbrush could be cleared away, for grass fires could become hot enough to cause explosions at some little distance. Olive groves, although sometimes used for shade, were decidedly fire hazards.

The British favored roadside storage, while the Americans used both roadside and area patterns, the areas being foothill, prairie, or woods. Some areas had rail sidings; others had only truck approaches—but no covered storage existed.

Ammunition of all calibers was stored in the open, subject to all weathers, temperatures, and humidities. Much ammunition from battlefields required renovation, and of this, much came to the depots for the work. Renovation of ammunition damaged by the elements was sometimes required. This work was in the main performed by native laborers under the supervision of ammunition-company soldiers.

Organization of the Ordnance Headquarters, Mediterranean Base Section, under the Ordnance Officer, comprised four operating divisions, besides administrative, adjutant, and troop divisions. They were procurement, maintenance, ammunition, and supply.

The supply division was divided into automotive, general-supply, and records sections until after the Tunisian campaign. At that time, SOS control over procurement and distribution of stocks was instituted, after which it was necessary to install the Ordnance provision system to provide information of stock status. Organization functionwise instead of productwise was then adopted, the division being divided into an operations section, controlling receipt, storage and issue activities, and transportation; and a requirements section, in charge of the operation of the Ordnance provision system and status reports.

The most important single factor in successful operation was the choice of personnel and organization. Personnel must be properly trained and capable of aggressive initiative. With the base operating full blast from the beginning, there was no time to learn on the job nor time to rely simply on training.

The Oran depot initially consisted of 50,000 square feet of covered space and 530,000 square feet of open space. Although this had increased to 158,000 square feet of covered space and 1,775,000 square feet of open space by June 1943, the space was still inadequate to relieve congestion. A typical day's business during the Tunisian campaign ran to about 100 tons and during the preparation for the Sicilian campaign to as much as 230 tons.

If a base is to be able to pick up full-scale operation from the first day, the organization must include officers who participated in the planning of the operation and accom-

panied combat troops from the beginning and through the initial stages of the campaign. This can best be accomplished by attaching officers to be assigned to Ordnance section base headquarters to the Ordnance staff of the task forces not simply as observers but as intimate participants in planning and operations, occupying or sharing key positions in task-force headquarters. Then when the time comes to activate the base, these officers will be fully informed of all problems that have come up or that may come up, and will know the extent of their task. If the base section were simply to follow combat troops and take up when the troops leave off, a dangerous gap would be left between them.

Similarly, the possible gap between supply and maintenance divisions within the base may be closed by appointment of "maintenance-supply" liaison officers in each of these activities.

IF medicine, technology, physics, and other sciences learn a great deal from the necessities and changes brought by war, the "science" of warmaking itself learns even more. That this fact, which ought to be obvious, is actually often ignored is shown in occasional criticisms directed at the military, and usually by the military, for not having anticipated this or that detail of, say, supply. We would not need to learn from experience in any field if we were gifted with prophecy. So we learn from our experience in battle as a matter of course; it is part of the job. In the Mediterranean Base Section we learned from experience, and did not thereby imply criticism of any one.

We learned that parts common—spark plugs, battery acid, welding rods, breaker points, bolts and nuts, hot and cold patches, oil filters, tools, and so forth—were required in much greater quantities than any one could possibly have foretold and that their ton-value to us in the theater was enormous. We did not get them with the former boxed lots of automatic supply, but the lesson is learned. Further initial supply is being based on African experience, and instead of supplying additional parts in sets, the zone of interior sends what parts are requested. We learned the hard way that spare parts and accessories should invariably be shipped with the vehicle.

Demand reflected in our stock activity showed the need for initially stocking large quantities—hundreds in place of tens—of unit assemblies. In periods of quiet, generators, starters, and so forth can be repaired, but during the pressure of active campaigns they often just have to be put to one side for repair or rebuild at a later date and a new or previously rebuilt unit installed.

Base operating needs such as typewriters, stencils, nails, towmotors, and calculators in adequate quantities should have a place in the initial shipment. The automatic supply of the first months of a campaign must by the most extreme care not suffer the omission of any commonly used item.

We believed that the heavy hand of the editors in the ports of embarkation upon our requisitions was often brought down on our supply arbitrarily and with little basis. Personnel acquainted with requisitions and their basis might well accompany them to the port to discuss particulars and get better results.

Good packaging is of extreme importance. Most packages have to be handled dozens of times before they reach their final destination, and they tend to fall apart unless they are strong enough to withstand dropping from, say, shoulder height, lifting with pincers, and similar handling conditions.

All goods should be identified by packing lists, legible and indestructible, placed inside and outside the boxes, and showing SNL (catalogue) group, correct nomenclature, part number, and quantity. In addition, it would be of material assistance if information relative to contents is stenciled on the outside package in such a manner that it can be readily identified during the rush attendant to discharging and moving cargo. Receiving operations of an overseas depot are speeded up eighty per cent if packing lists containing complete information can be used for tally-in procedures.

The need of special training of all men to be assigned to headquarters work was abundantly proved. "Common labor" troops will not do. Most soldiers in the Mediterranean Base Section became at times foremen—"specialists" in charge of groups of inexperienced natives. All men in supply, for instance, need a working knowledge of the Ordnance provision system. We learned that the Ordnance regimental organization was all right, and that there was some loss of morale when the regiments were broken up.

"Specializing" companies—such as those trained only for antiaircraft or tire repair were not entirely satisfactory— because there is not always sufficient work for them. Where antiaircraft guns are little used, the companies should be employed for other Ordnance activities except that they may be short of equipment, training, and spirit for another task. It was generally felt that these special types of equipment and personnel might better be in old-type maintenance companies, heavy and medium, and that any time there was a great deal of work for them there would be enough maintenance companies available to withdraw the trained personnel and special equipment to make up the special groups.

THE difficulties of supply for the North African campaigns were twofold: vast distances and lack of actual experience. Both conditions have now been largely removed. Further attacks against Europe now will be able to jump off closer to their objectives, and the experience gained in Africa also will go far toward correcting and improving all aspects of supply and maintenance of ordnance. But when our troops landed on the African continent they were a long way from home and a long way from supply bases. Much had to be prejudged and advance-planned, because the base could not quickly respond to new demands, unanticipated situations, or changes of the military situation.

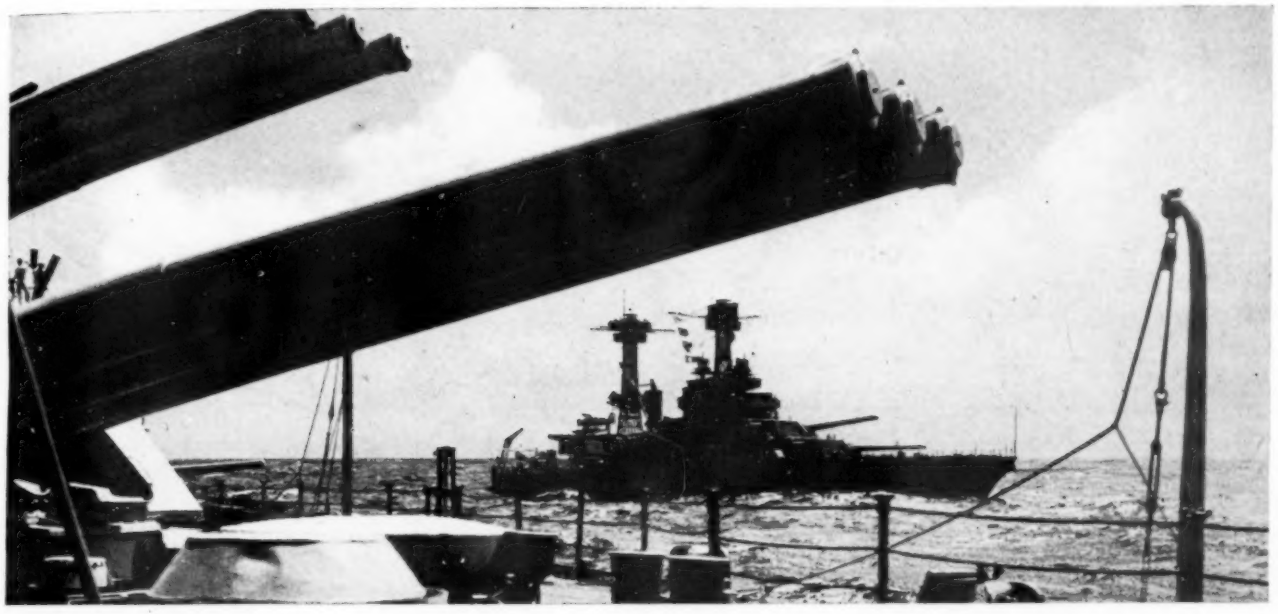
The supply agencies in the zone of the interior have now received some of the results—the experience data accumulated in actual operations. They have been told that a comparatively small fraction of some types of parts that were shipped would have cared for a large fraction of the demands. They now have actual consumption figures for given numbers of weapons and vehicles under given conditions.

Confusions of shipping which were formerly inevitable due to submarine attack and ship shortages may now largely disappear; similarly losses due to failure of identification or of protection against corrosion or breakage are being eliminated.

The proof of supply is in the fighting. While there was in North Africa, and will be elsewhere, a margin of improvisation between the supply strategy and the consuming needs of the combat troops, there was never a single instance of failure to supply the troops in time and in sufficient quantity and quality with the ordnance they actually required to do the job.

Guns for the Navy

THE long-awaited allied invasion of Germany's "European fortress" which struck the Cherbourg Peninsula and the Norman coast of France on June 6th, as well as subsequent landings, was made under the protecting cover of ground, sea, and air ordnance. Invading troops who came by landing craft and glider were armed with carbines, rifles, submachine guns, mortars, light and heavy machine guns, bazookas, hand grenades, and demolition charges. Artillery units were put ashore, and tanks and self-propelled weapons also supported the firepower of the ground troops.



The allied air armada not only convoyed thousands of parachute and glider troops to their objectives inland but flew a record number of sorties in protecting the beaches and driving back the enemy with machine guns and bombs.

It was allied sea power, however, which shepherded the myriad landing craft, stood guard against attacking submarines and hostile aircraft, and destroyed pillboxes and heavy shore fortifications with long-range guns, thus making it possible for our troops to land and advance against greatly reduced opposition.

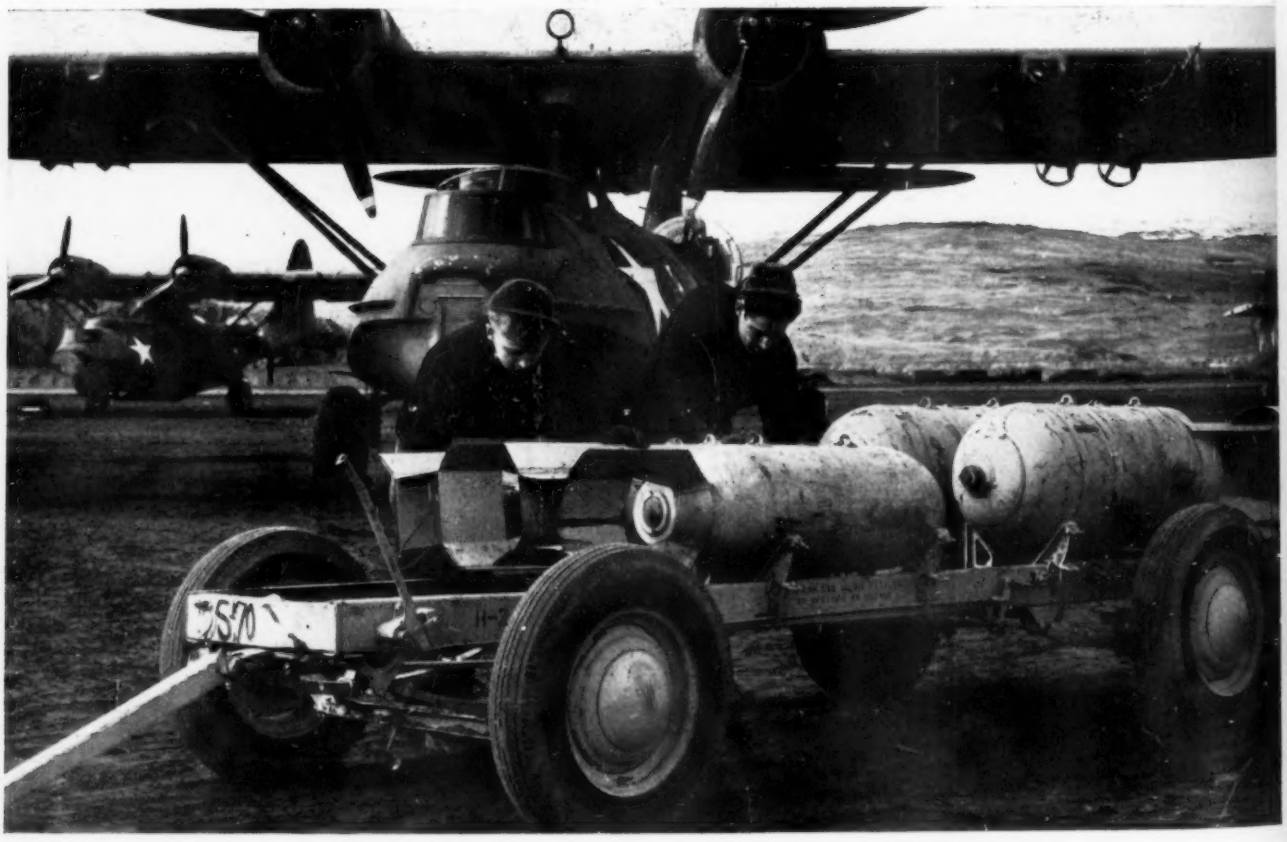
Modern naval ordnance comprises guns of all calibers—from half an inch to 16 inches and weighing from 100 pounds to 100 tons; their mounts ranging from a pedestal of 300 pounds to an armored 3-gun 16-inch turret weighing as much as a whole destroyer. Naval ordnance also includes projectiles of all types—armor-piercing, antiaircraft, incendiary, illuminating, shore-bombardment—and fuzes and high explosives for bursting these shells.

Before these powerful weapons can be used, however, a great deal of high-precision apparatus and equipment also must be provided, such as hoists and rammers to bring the ammunition from the shell rooms and magazines and load it into the guns; range finders; computing, transmitting, and receiving instruments; and gun directors for directing the shells accurately to the target. The Navy's Bureau of Ordnance is responsible for developing and procuring all these things as well as heavy armor—some of it thicker than the diameter of the 16-inch shells it must keep out; torpedoes for destroyers, cruisers, PT boats, submarines, and airplanes; bombs and bombsights; mines of various types; depth charges and their projectors; nets and booms for protecting naval anchorages; flares, rockets, and other pyrotechnics. Naval ordnance includes these and everything in the Navy which is hurled at the enemy by ships and naval planes.

The invasion of Europe is truly a combined operation, not only in its tactical phase but also in the united firepower of the land, sea, and air ordnance of the United Nations. Modern weapons and ammunition supplied by loyal workers on the home front and wielded by our courageous fighters abroad will, we pray, soon bring victory to our cause and peace to the world. (Accompanying illustrations on this and the following pages are from U. S. Navy photographs.)

Air and Undersea Defense

The twin-mounted cal. .50 machine guns shown above on a PT boat provide excellent defense against low-flying planes, while the depth charges, seen at the right, are effective antisubmarine weapons as are the depth bombs, below, about to be loaded on a patrol plane. Both types can be set to explode at any desired depth and are actuated by hydrostatic pressure.



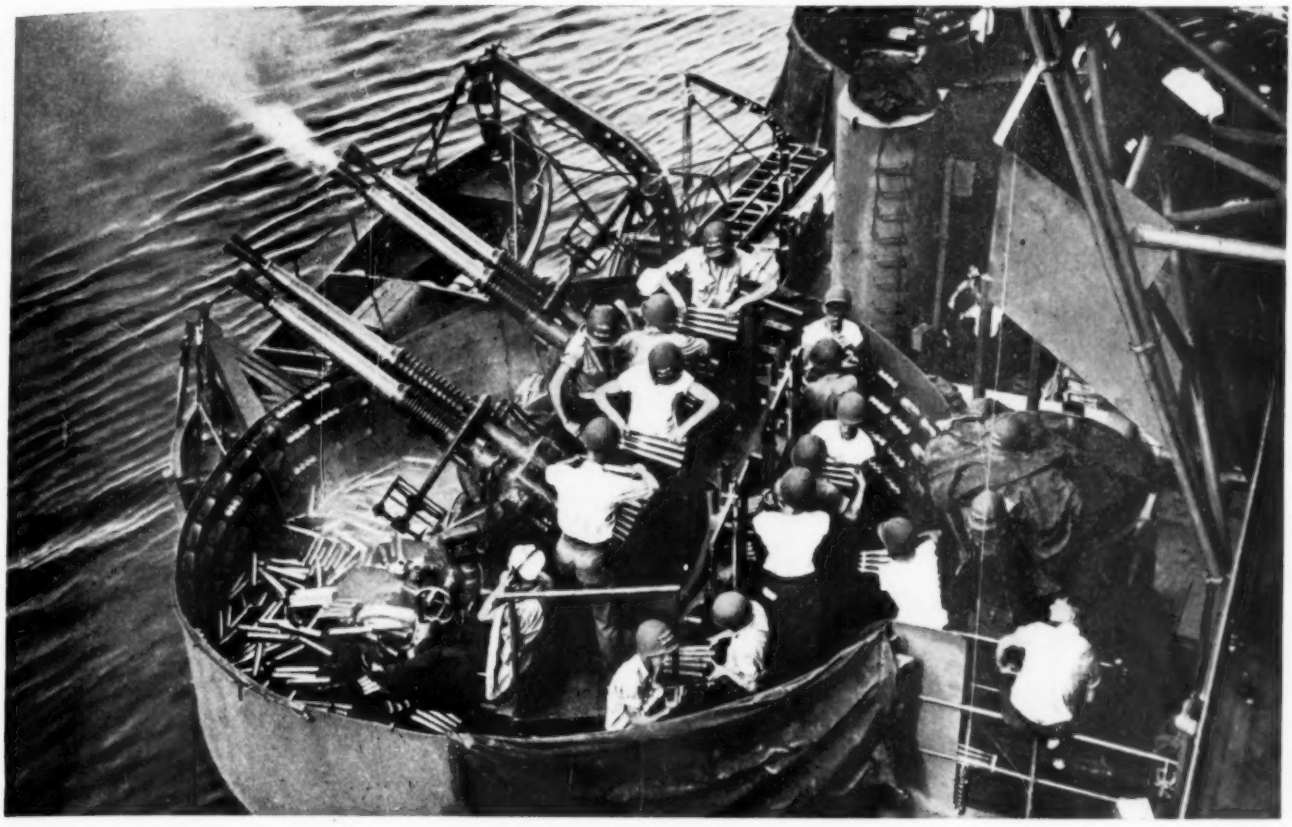
Torpedoes and Pom-Poms

Torpedoes, one of which is shown above leaving a twin tube, are among the deadliest of naval weapons and are carried by destroyers, light cruisers, submarines, PT boats, and airplanes. Once in the water the torpedo generates its own power and is guided by gyroscopic control. The "Chicago Piano," a multiple 1.1-inch pom-pom, is shown in the illustration below.

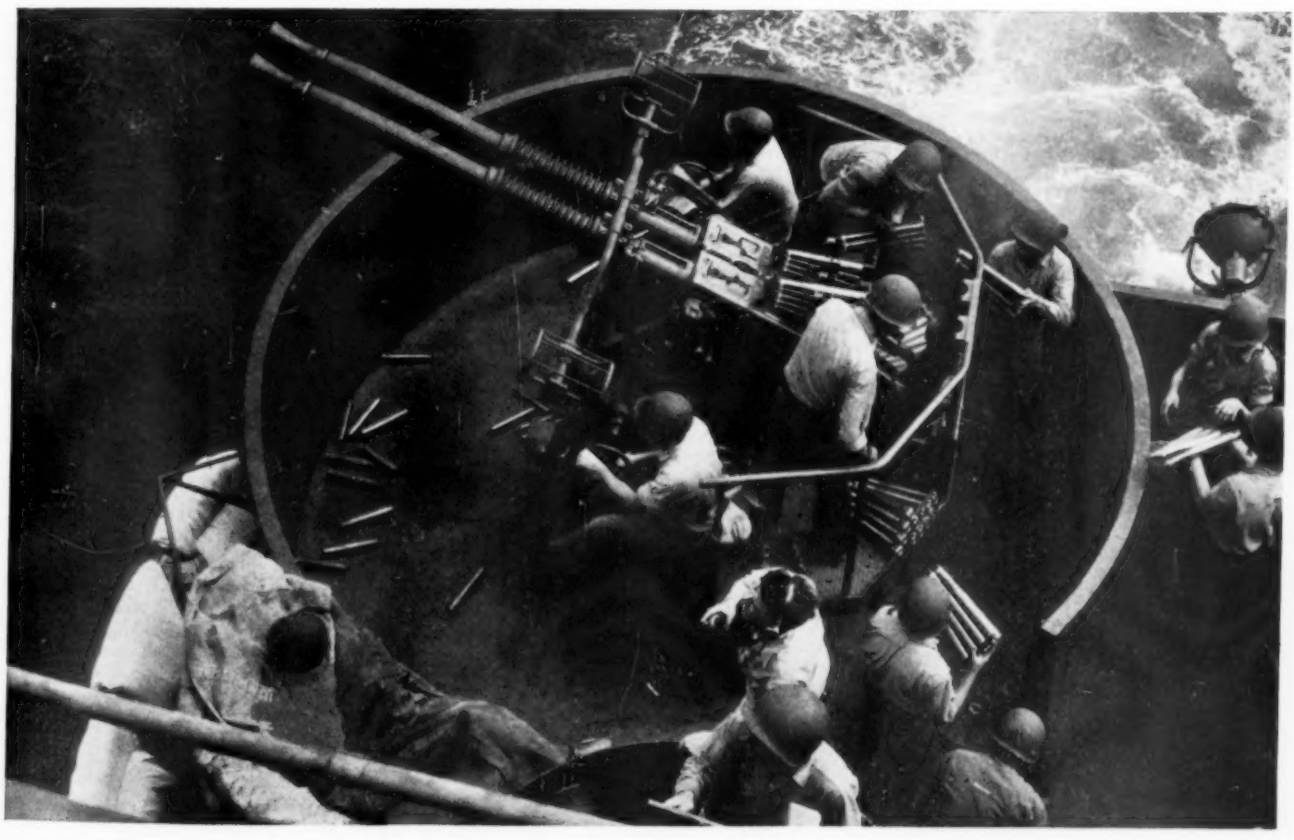
The 20-mm. Antiaircraft Gun

Although antiaircraft guns are defensive weapons and therefore do not win decisive battles, they are of vital importance in keeping our ships afloat to use their offensive arms. The 20-mm. automatic antiaircraft guns illustrated here have proved almost a specific remedy for enemy dive-bombing attacks. They fire explosive ammunition with sensitive contact fuzes.

The 40-mm. Antiaircraft Gun

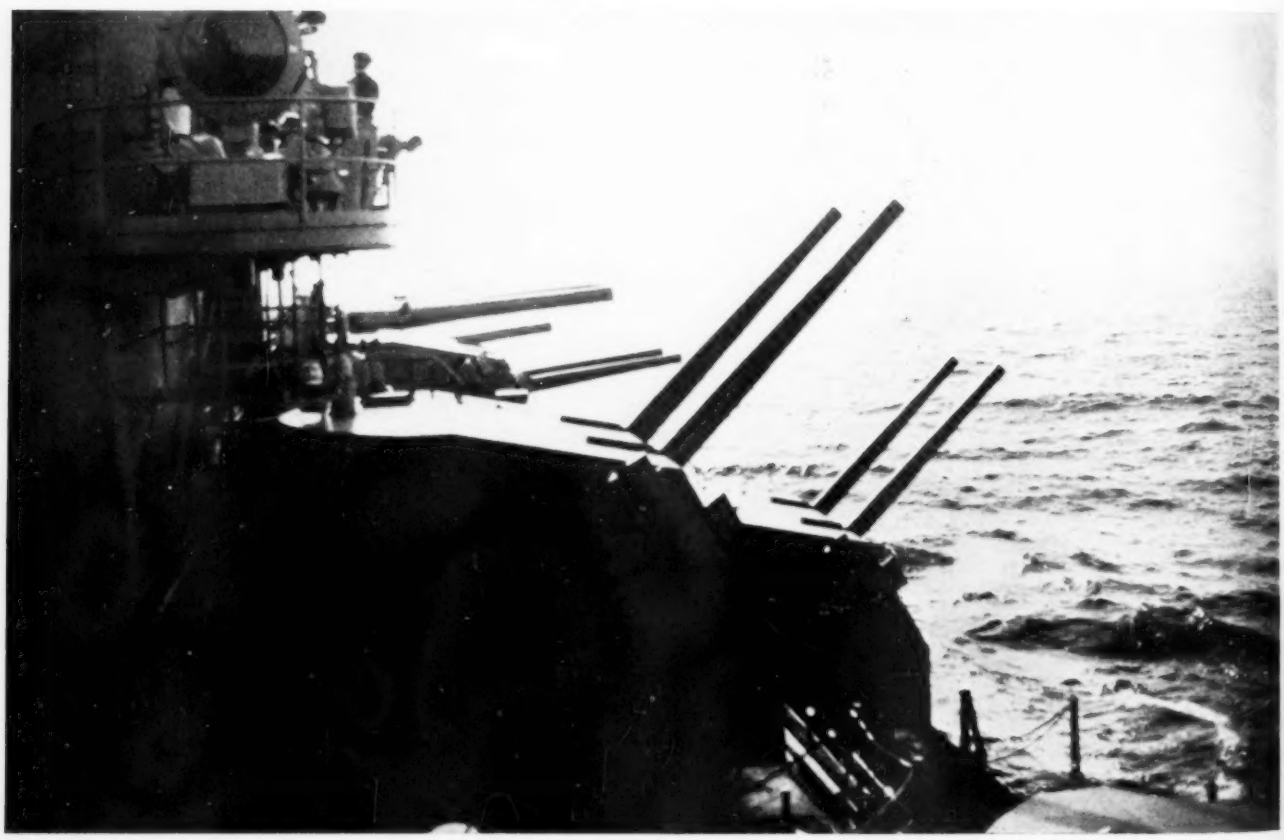


The 40-mm. antiaircraft gun is another powerful defensive naval weapon. It is made in quadruple mounts, as shown above, or in the twin mounting shown below. The guns fire high-explosive ammunition which is fed into the hoppers in clips of four. The 40-mm. may be aimed manually, but it is especially effective when directed by the ship's fire-control instruments.

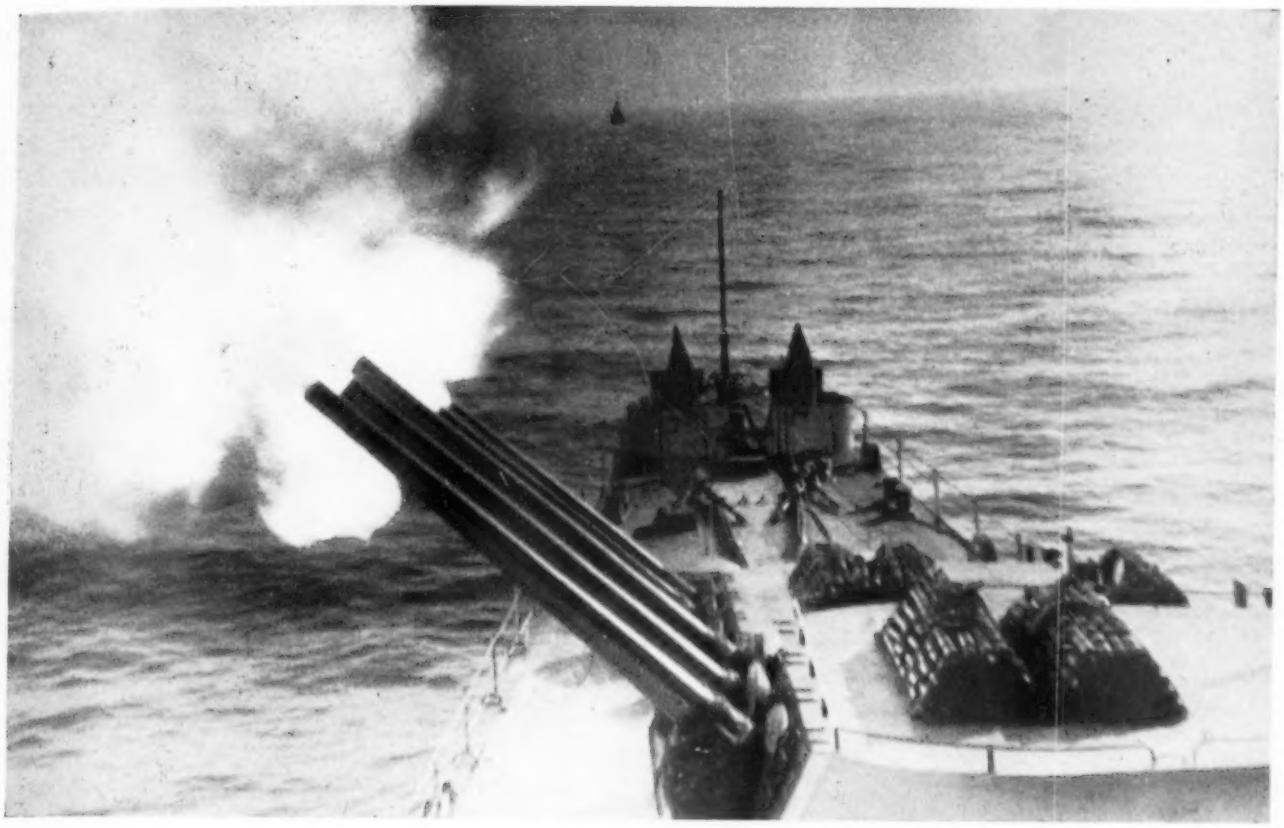


Dual-Purpose Guns—4- and 5-inch

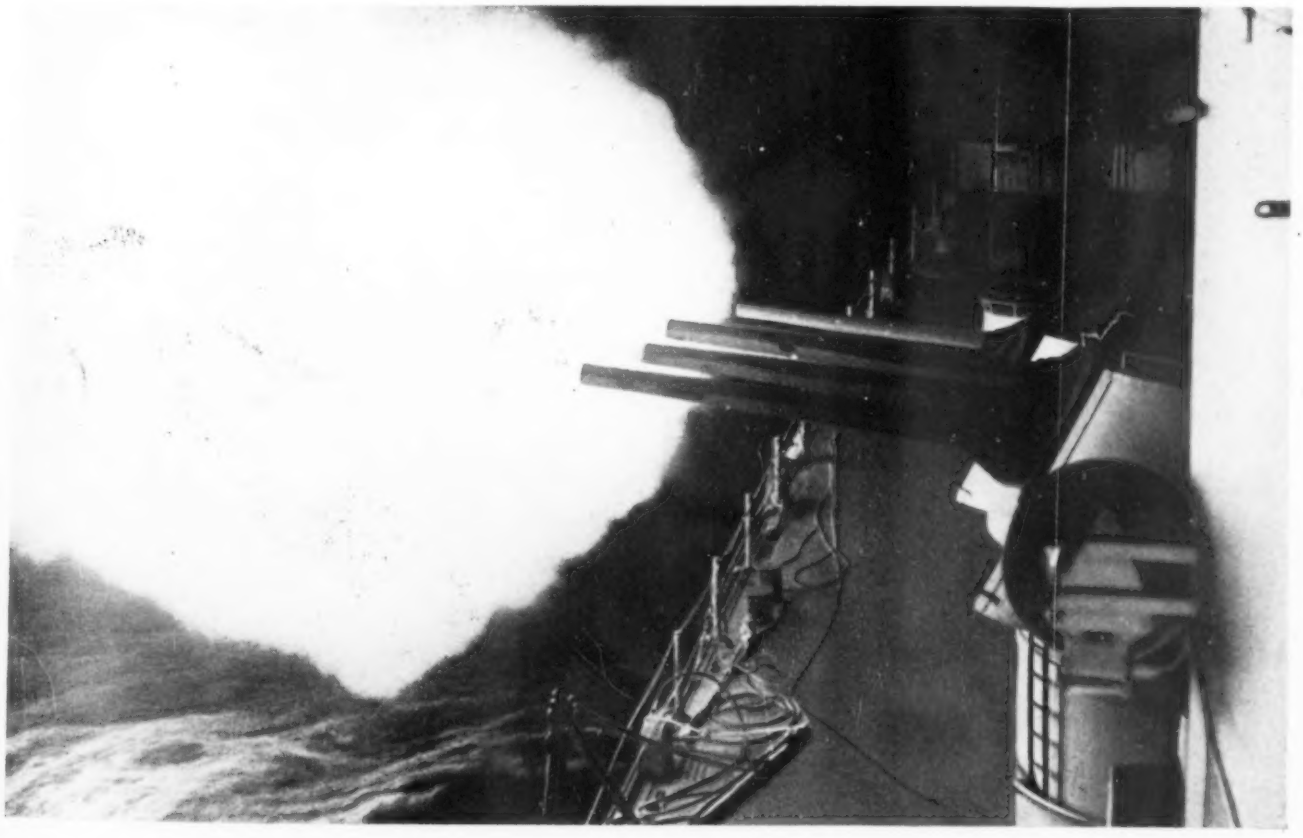
The 4-inch 50-caliber gun, above, can be employed against both aircraft and surface targets. Guns of the USS NORTH CAROLINA'S *5-inch antiaircraft battery, shown below, are also dual-purpose weapons and are especially effective against high-flying aircraft. The number of antiaircraft guns on our warships has been increased greatly since Pearl Harbor.*



Cruiser Armament—6- and 8-inch Guns

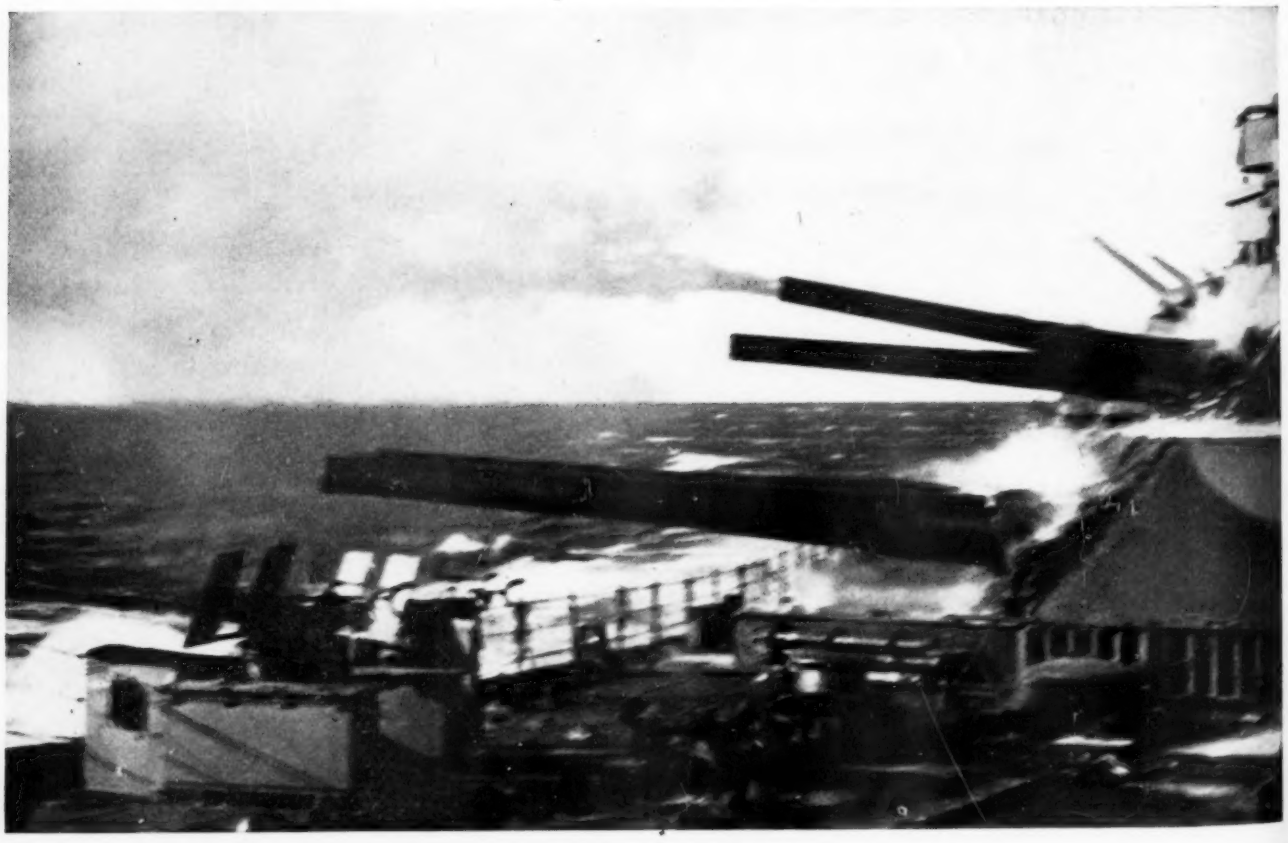


The 6-inch rifles of our modern light cruisers, above, have no equal for fast and accurate shooting. They are mounted in five 3-gun turrets and fire shells weighing over a hundred pounds. Heavy cruisers mount 8-inch guns, below, firing projectiles of 250 pounds which are very damaging to surface targets; thin-walled shells are used for shore bombardment.



Big Guns of the Fleet

The most powerful naval weapons are still the big guns of the battleship, such as the 14-inch rifles shown above or the great 16-inch guns below. The latter weigh about a hundred tons and fire 1-ton projectiles at a speed of half a mile a second to a distance of more than twenty-five miles with far greater accuracy than a high-altitude bomber can achieve.



Safety in Explosives Plants

Achievements of the Ordnance Safety and Security Branch

Col. Crosby Field

THE Chief of Ordnance, in order to achieve safety in Army explosives plants assigned to his continuing protection responsibility, set up an organization for this purpose in 1942. The success of this method is indicated by the fact that not only has the accident-frequency rate in those plants decreased nearly two-thirds since this act on his part, but this frequency rate is, on the average, less than one-half the average frequency rate of all industry. Furthermore, the frequency rate of accidents due to fires or explosions in explosives facilities is one-twentieth the average frequency rate for ordinary industrial accidents occurring in the same plants.

Regardless of the type of ownership of a plant or the method of operation, all plants involved in war work are classified into one of four or more classes, depending upon the degree of essentiality that their output bears to the war effort. In considering the protection of the plant, therefore, the number of inspections for safety and security, the recommendations made, and the many other factors involved vary with the priority classification based upon its degree of importance in the war effort.

All plants engaged in the war effort are assigned to one or the other of the branches of the Government for what is known as their "continuing protection responsibility." These assignments are duly recorded in a "confidential" master responsibility list which is continuously being brought up to date as changes in plant and contracts are made. Besides the Navy and the Army Air Forces, to each of which continuing protection responsibility for some plants is assigned, most of the plants manufacturing for the Army are assigned for continuing protection responsibility to the Office of the Provost Marshal General, Army Service Forces. This group sets up policies and maintains a general supervision over all safety and security work which, except for the assignments given below, is actually performed by the various service commands, each command being responsible for the plants within the territorial limits assigned to it.

Three exceptions are made. Certain plants are assigned on the master responsibility list to the Chief of Engineers, others to the Chief of the Chemical Warfare Service, and still others to the Ordnance Department. Those assigned to the Ordnance Department comprise those in which powder, explosives, or their ingredients are manufactured, processed, or stored.

In accepting the responsibility for the continuing protection responsibility of these plants, Maj. Gen. L. H. Campbell, Jr., immediately after his appointment as Chief of Ordnance, established the Safety and Security Branch, placing at its head Col. F. H. Miles, Jr., as Director of Safety. Colonel Miles is universally recognized today as an officer of the broadest experience with explosives, including detailed knowledge of the practice and theory of their development, manufacture, and use and who is probably the best informed man in the Army on ammunition.

Colonel Field is Assistant Director of Safety, Ordnance Department, U. S. Army.

The principal objective of the safety section of the Safety and Security Branch is to develop and have adopted by the operating management of a plant proper protective procedure against the hazards which have been discovered in each operation. This includes inspection of the design of buildings, equipment, and their layout; their method of operation, including maintenance; selection, training, and supervision, from a safety viewpoint, of the personnel necessary to the operations; maintenance and inspection of plant for equipment, and the handling and storage of the products, their components, and ingredients. This further requires frequent inspections to insure that the developments thus arrived at are continued in effect.

IN its work, the safety section has to maintain intimate contact with representatives of four large groups of people including the following:

1. Experts of the various industries, in which the safety section must function. Representatives of these industries have been placed on advisory committees of the section, thus forming what might be called an advisory unit.

2. Sources of information regarding hazards and the proper protection against such hazards, which sources may be within the Ordnance Department or other Federal agencies, or within other organizations. In order to maintain these contacts and to develop its own standards, a technical unit has been formed in the safety section.

3. In order that a channel may be provided for communications to and from plants and in order that safety in those plants may be administered and followed up, a plant unit has been formed in the safety section. All plants for which this branch has continuing inspection responsibility have been assigned to one or the other of the groups in the plant unit, and the chief of a plant-unit group is charged with seeing to it that the plants in his assignment are properly serviced and safety-audited and that recommendations are carried out, utilizing the proper organization channels.

The allocation of the plants according to groups naturally is related to the type of manufacture or operation encountered, those plants having similar operations being grouped together. The chief of the plant-unit group is automatically the secretary of the advisory unit committee of experts from the industry in which his group operates, so that there is a very close tie-in between the experts of the industry and the group chief, his auditors actually making the safety inspections. This intimate relationship has been of great assistance in determining the basis for acceptable standards, and then in their formulation. Furthermore, through the close coöperation which thus exists between representatives of industry and the chiefs of the various plant-unit groups, efforts have been made to bring substandard plants up to the safety level attained by the better plants in the industry.

4. A training unit has been formed. One of the major difficulties in the establishment of this section has been to obtain properly qualified personnel. It soon became apparent that such were not obtainable without a course of training, and

therefore a training unit was set up. This training unit not only has enrolled the necessary personnel and then trained them as well, but has also provided training courses to which contractors operating plants, Ordnance districts, and others have sent men to be trained.

The primary function of the school for safety auditors is to train the safety section's own staff at headquarters, its representatives at the district offices, and in particular its safety auditors (or inspectors). It was soon discovered that although there were men available with some fire-protection experience and knowledge or with some industrial-safety experience or knowledge, there were very few available having sufficient of either or both types of qualifications, together with a knowledge of explosives, to enable them to undertake the work of the safety section in any of its particular functions. It became necessary, therefore, to train these new employees, and the School for Safety Auditors was started to impart to selected members of the Explosives Safety Branch, Office of the Chief of Ordnance (now the Safety and Security Branch), knowledge of the hazards involved in manufacturing, handling, and storing explosives, and of the methods available for preventing accidents in these activities, as well as of minimizing the effects of such accidents should they occur.

The work of the industrial-hygiene group, comprising officers assigned to the Safety and Security Branch from the Surgeon General's Office of the Army and the Surgeon General of the United States Public Health Service, has been very effective. In addition to taking care of numerous inquiries, inspections, and conferences required for changing conditions in these plants and issuing circular letters of advice on industrial hygiene, this group also holds large conferences or small conventions at which are present not only medical specialists but also the medical directors of the various Government plants, and the subjects of industrial health, hygiene, and poisoning due to handling toxic explosives are thoroughly discussed.

The branch publishes periodically the *Statistical Review,* which gives not only the accident severity and frequency rates of each and every plant assigned statistically to the branch but furthermore makes an analysis of the accident, studying the type of disability and nature of injury, unsafe act by type of accident and unsafe personal factor, type of agency by type of accident, unsafe mechanical or physical condition and occupation and type of accident by unsafe mechanical condition. These data have been found to be of considerable assistance in combating untoward frequency rates at these plants. In addition, the placing of the plants in a series according to their accident rates has inspired a healthy rivalry between them which has assisted greatly in instilling in management as well as in the worker a desire for plant safety.

Acting upon the theory that it is the duty of the Safety and Security Branch to determine all hazards, preferably before a fire or explosion results, but in any event to determine them, this branch makes a thorough investigation of all fires or explosions, determining the cause whenever that determination is possible. The branch has evolved its own method which, up to the present, has proved quite successful for determining the cause of fires and explosions. The reports of fires or explosions are briefed into "abstracts" which are promptly furnished other plants having the same hazards in order that they may be warned of the possibility of their operations producing a fire or explosion and act accordingly. There are several cases on record where the information contained in the abstracts has enabled plant management to take action which precluded a similar explosion in their own plants.

The work of the security section of the branch is similar to that of the safety section in that its organization is such as to provide liaison with representatives of all the various groups with which the security section has to maintain close contact. Among the many functions which the section has to perform may be mentioned supervision of investigative systems for prospective employees; control of aliens, criminals, and visitors; dissemination of morale-building information including distribution (but not production) of posters advocating safety, security, and morale; awards of merit for extraordinary acts of morale and other things, such as marksmanship of guards; coöperation in the publishing of plant organs, in so far as safety and security are concerned; and the open and undercover control of subversive and criminal activities. It further includes the dissemination to the local press of morale, safety, and security information essential to the development of the morale and coöperation of the community; the development of disaster-plan procedures and reports on disasters; and evacuation and relocation plans.

This branch has been most fortunate in having outstanding and distinguished representatives of industry accept appointments on the Safety and Security Branch Safety Council, which also includes the Surgeon General, U. S. Army; the Surgeon General, U. S. Public Health Service; the commissioner of police, New York City; the director of the Bureau of Mines; the assistant chief inspector, bureau of explosives, the Association of American Railroads; and the president of the National Safety Council. These men have unselfishly devoted considerable time in meetings and in other activities to the work of this branch and have set the broad general policies on which the branch is operated. They have further reviewed the activities and achievements of the branch periodically and have guided the selection of its objectives as well as its methods and procedures.

IN its program, the Safety and Security Branch recognizes certain fundamentals. While these are generally parallel to many usual industrial-safety activities, there are certain items which require specific attention, including the following: Plant location, housekeeping, fire protection, protective clothing, handling and transportation of explosives, employee population proportionate to operations, quantity-distance relationship, destruction of scrap or reject material, first-aid and medical facilities, change houses, and the enforcement of safety regulations.

While, in some instances, it is necessary to utilize existing industrial facilities, in general, a plant for the manufacture of explosives or the loading of ammunition should be located in a sparsely settled section of the country where there is sufficient space to permit the erection of manufacturing lines and buildings in accordance with established safety procedure. A flat terrain is preferable, but a certain amount of rolling country can be utilized. Obviously, level country provides ease of installation of highways and railroad equipment and facilitates economic transportation of raw materials and products. Due consideration must be given to a good source of water supply, not only for manufacturing purposes but to provide adequate fire protection.

The best means of fire protection is to build a plant of fire-resistant materials throughout. Important material should be safeguarded from fire loss by subdivision. Wherever possible,

storage of essential material, equipment, and finished goods should be so arranged that no single fire or accident can destroy all available units of any particular item. This may be accomplished by the erection of storage units in various locations remote from each other or by separate storage in a single building provided with standard fire walls having properly protected openings. Large single areas should be avoided. Substantial physical barriers or complete fire-wall cutoffs should be installed, dividing large areas into separate manufacturing operations, thus limiting the spread of fire even under the most adverse conditions. Such cutoffs should always be constructed between floors.

PRIMARY and secondary fire protection are required. First-aid fire-fighting equipment, such as fire pails and water barrels, extinguishers, and small hoses are valuable during working hours in the hands of capable fire brigades if used promptly and with good judgment on incipient fires. Foam-type extinguishers are recommended for use near inflammable liquids, while carbon-dioxide extinguishers should be available for use on electrical fires or where delicate and valuable equipment may be damaged by the use of other types of extinguishers. Extinguishers must be kept full and in good working order. It is desirable to seal extinguishers to prevent malicious tampering. When a plant is of sufficient size, the plant fire brigade should be augmented by a full-time fire department under competent supervision and suitably equipped with powered pumpers and hose trucks.

No fire-protective system is better than its water supply. The entire premises should be covered by a looped or gridded system of fire mains with hydrants and shutoffs. If a municipal or public water system is relied upon, service connections must be of sufficient capacity and should be augmented by the installation of gravity tanks, fire pumps, and private reservoirs. Duplicate sources of private water supply are recommended.

Wherever the material being handled will permit, automatic sprinkler systems should be installed as these, on the basis of past experience, have held under control at least ninety-eight per cent of all fires. No other single fire-protection device has done so much to reduce interruption of production caused by fire. Contact with public fire-alarm systems and with adjacent public fire departments is important. The chief of the public fire department should be brought to the plant and given an opportunity to become familiar with the private fire-protective system, so that if a fire occurs he will know exactly what plan to follow.

The correct number of workers to populate any given operation must be established. Anxiety to complete a production program should never excuse crowding. The first fundamental principle of safety in an explosive plant is to expose the least number of employees to the least amount of explosive consistent with economic and continuous operation. Once the relation between maximum number of workers and the correct amount of explosive has been established, it should be posted in the workroom or area and then enforced. No deviation from this rule should be countenanced.

In a plant layout, it is essential to establish a relationship between the amount of explosive being used in an area and the permissible distance to any adjacent area. This quantity-distance requirement must be recognized when the plant is constructed. Certain tables have been developed, based on comprehensive tests at proving grounds and on the actual records of fires and explosions involving explosives and ammunition. The tables established, pertaining to each particular class of ammunition or explosive, recognize the possibility of a hazardous fire during manufacturing, processing, or handling; the destruction from sympathetic detonations; the hazards from flying missiles projected either as pieces of broken containers or complete rounds of ammunition; and the effects of the concussion produced by the detonation of a quantity of explosives.

The possibility of structural damage to inhabited buildings, railroad and automotive equipment, and the injury of persons located at any point external to the plant itself has been considered. In addition, the same relationship has been studied and developed, covering the permissible amount of explosives to be handled within any plant operations or line and the distance to any factory building within the same manufacturing line or area. The use of these quantity-distance tables has had much to do with the good record produced by the explosives industry.

Safety in the handling and transportation of explosives or ammunition includes the handling of the least significant primer to the final transportation of the largest bomb. Each individual explosive, component, or final product entails a different safety procedure which must be developed, based on knowledge of the inherent hazards as well as the method of production. In general, quantities should be held to the absolute process minimum where hand or hand-truck transportation is involved.

Plant layouts must be such that workers have sufficient space in which to function. An example of the neglect of this principle recently occurred where the permission to allow two workers to work in a space normally designed for one was a contributing factor to a major disaster. The rough handling by workers of any explosive must not be permitted. Trays, tote boxes, and other containers must always be kept in good order and the components or materials handled should be supported or so packed that they will not strike against each other. Containers of hazardous material or loaded components must not be dragged, dropped, or thrown about but must be lifted or trucked.

WHEN locomotive or automotive equipment is used for transportation, it must be of a type suitable for such work. Locomotives must be of such type that they cannot set or communicate fire. Locomotives should not remain in front of buildings containing hazardous materials. When necessary to spot cars for loading and unloading, the doors to such buildings should be closed when the locomotive is passing. All railroad cars, trucks, and any other vehicle used in the transportation of hazardous or explosive materials should be so constructed that no part of the load can fall off. Motor trucks and other carriers should have wood floors and sides. Automotive equipment used in the transportation of explosives or loaded ammunition must be kept continuously in good operating condition, particularly as to brakes, tail gates, fuel leaks, etc., and frequent inspection, preferably daily, should be made of each vehicle to insure it is constantly ready for safe operation. Any truck or vehicle loaded with hazardous material should never be left unguarded.

When manufacturing or handling includes intimate or personal exposure to explosives or other similar hazardous materials, special clothing should be furnished employees. Safety uniforms or special clothing should always be worn when required and should be of a type having no metal buttons, no pockets—other than a skeleton pocket—and

should be of a hard-surfaced, close-woven material. When such safety uniforms are used, a complete change of clothing is recommended so that street clothes will not be worn at work and the clothes which have been exposed to the hazardous material will not be taken from the plant. Operations where fine explosive dust is generated or where hazardous vapors occur may require special footwear, and the personnel exposed must wear shoes with conductive soles to permit grounding the static charges developed by the body. In such hazardous areas, all floors should be of the so-called conductive type, having an extremely low electrical resistance to ground, and should be suitably grounded at several points.

As in any other type of manufacturing establishment, it holds true in an explosive plant that good housekeeping is a fundamental and important principle of accident or fire prevention. General good order and neatness can do much to reduce the number of accidents and personal injuries, will permit pride in the place of employment, and will result in a better product. "A place for everything and everything in its place" is a much better program and an easier one to follow than periodic cleanups. Good housekeeping practices should not be confined to manufacturing areas alone; it is equally essential outside manufacturing areas. Rubbish, dry grass, and other forms of waste must never be permitted to accumulate in outside areas where they may produce an exposure to the plant if a fire should occur in such materials.

Closely allied with good housekeeping is sanitation, the lack of which in any establishment may affect the alertness of the workers. Frequently, accidents may be traced to unfit conditions and to unwholesome and unhygienic practices, not only in the plant but in the home. Adequate change houses are recommended where the changing of clothing can be facilitated, where proper use of sanitary features can be supervised, and where personal cleanliness may be required or insisted upon.

Industrial wastes require separate disposal. Waste water from a laundry where explosives operators' clothing is washed, or other waste water containing explosives, must run through settling tanks or pits to remove the explosive before it creates a hazard by settling out or by the contamination of the soil or other water.

It is important that a suitable burning ground, disposal or destruction area be established. All material from cleanup operations and all rejected product should be destroyed at this area which, by its isolated location, removes the hazard from other areas. The disposal of all waste material should be under the control of a competent employee thoroughly familiar with the inherent hazards.

A COMPREHENSIVE plan for medical control is essential. Obviously, this plan must be based on the number of persons employed and should be varied when necessary to make positive that adequate medical control is established. If needed, a complete plant hospital should be provided and should be in the charge of a competent physician. Dressing stations should be located at strategic points within or near explosives areas, key personnel should be trained in the use of first-aid materials, and contact relations should be made with outside emergency facilities such as hospitals, ambulance services, auxiliary corps, and with additional medical assistance in the event a catastrophe demands additional help. In every plant, emergency and rescue squads should be selected from each shift personnel and trained. These squads should receive regular instruction from the medical director and should participate in simulated emergency-training demonstrations to become familiar with emergency technique which might be required in any operating area.

While it has been stated that the safety program of an explosive plant is fundamentally no different from a similar program in a nonexplosive endeavor, yet it can fail to attain its objective if it does not include some means of enforcing the safety instructions and regulations. The mere formulation of safety rules, the development and construction of a plant complying with all known safety practices, the provision of proper safety clothing and sanitary facilities, and the maintenance of good manufacturing procedure cannot hold to a minimum injuries and cases of industrial disease unless there is established at the same time a very definite program of enforcement. A large plant may warrant the establishment of a safety department in charge of an industrial-safety engineer. A smaller plant may require that the safety program be carried on solely by foremen, but many plants may require that an employer-employee combination work on this important problem so that the compliance with safe-practice rules will be as well established as compliance with the rules and instructions relating to the quality of the manufactured product. The responsibility for such activity is not confined to the supervisory personnel but must include the education and supervision of every worker.

Safety committees and foremen's committees should be organized, accident causes should be developed, based on adequate and complete investigation of any injuries or similar occurrences, and, from such statistical data, practical operating rules established. It is essential that a sense of responsibility be developed so every individual will realize that any act on his part not consonant with good procedure may create the setting for an accident which will not only injure him but his assoicates as well and, at the same time, may interfere with our war effort. The foreman is undoubtedly the key man. He must first become not only "safety-minded" but "safety-habited"; then all the workers reporting to him, in following his example, will become safety-habited.

In all this work it must be understood that the Safety and Security Branch functions solely as a staff and therefore does not claim more than is proper for a staff to claim for this favorable showing in accident-frequency reduction and elimination of fires and explosions. Commendation belongs to the contractors operating the plants who are, after all, principally responsible for obtaining safety therein. Credit must also be given to the commanding officers, the Field Director of Ammunition Plants, the Small Arms Ammunition Suboffice, the Field Service Division, and the numerous other agencies which have coöperated in this work, including those states such as New Jersey, New York, Illinois, and Ohio, which have called upon this branch for technical assistance in connection with the formulation of an explosives code of laws and the inspection and enforcement thereof.

Thanks must also be given to the industrialists and technicians who have sat on the safety advisory committees and who have acted as special consultants. These men, serving without remuneration and at quite considerable expense, have unselfishly devoted their time and ability to assisting the Safety and Security Branch in many ways. Without the help of those mentioned and also the continued coöperation of all officers of the Ordnance Department, other governmental agencies, insurance companies, and American citizens in general who are interested in safety, accomplishment along these lines would have been impossible.

Postwar Preparedness

A Proposed Military-Industrial Program for the National Defense

THE following statement of principles on the postwar policy of the Army Ordnance Association was prepared and adopted by a board constituted for this purpose under the chairmanship of Col. William W. Coleman, vice-president of the Association. Other members of the board are Col. Herbert A. Gidney and Col. A. W. Herrington, national directors of the society.

There are two fundamentally different objectives imposed upon a nation when it is confronted with the task of interrupting its peacetime economy and exerting every possible effort for its own preservation in modern war. These objectives are:

First, the military-technical problem of mobilizing the greatest practicable proportion of the national man power for the war effort itself. The principal direction of this work must fall upon the experienced ground, naval, and air forces. *This is the military phase of our national defense.*

Secondly, the problem of the utilization of the country's available material resources and man power for the supply of the armed forces and the maintenance of the productive economy of the country itself must be borne by a mobilization of the industrial power of the country. *This is the industrial phase of our national defense.*

Continuing preparation must be made in time of peace to meet these two objectives. The speed and scope of modern warfare require that our country, in all its activities, be strong at all times to meet its military and economic burdens immediately an emergency arises. The victor in another World War will not, necessarily, be the strongest nation but the nation which can mobilize its strength without a moment of delay.

(Continued overleaf)

I. The Military Phase

The planning and implementation of our national defense to meet the military phase obviously requires intimate coöperation between and effective integration of all the armed elements. As a minimum there should be provided for the military phase in time of peace:

1. *Armed Forces of the Regular Services (Ground, Navy, Air)* adequate in number and properly trained to constitute our first line of defense for the enforcement of all committments of the United States wherever they may be.

2. *An Armed Forces Reserve* adequate in strength and of proper composition and training to furnish the mass of the armed forces required in a major war. A system of universal military training and service to this end would seem to be necessary.

3. *An Armed Services Staff College* as the apex of a defense training system which should include all elements necessary to train the Armed Forces of the Regular Service and the Reserve in strategy, tactics, and logistics.

II. The Industrial Phase

Implementation of our national defense to meet the industrial phase presents a much more difficult continuing organizational problem. The entire national economy is vitally concerned and practically every agency of Government and industry —including capital, management, and labor—is seriously involved. As a minimum, there should be provided for the industrial phase in time of peace:

1. *A Director of Industrial Mobilization,* whose functions should be established by statute, who should report to the President of the United States. The Director should prepare plans for all phases of economic and industrial organization necessary to supply the requirements of the armed forces and civilian needs in the event of war. He should perform supervisory and directive functions as to the several executive departments and independent offices of the National Government with respect to such plans. He should have no operational functions in respect to the work assigned to those agencies.

2. *An allocation of responsibilities, functions, and duties by the Director of Industrial Mobilization* to the executive departments and independent offices of the National Government and to the several States, defining their respective responsibilities, functions, and duties as to industrial mobilization.

3. *An Industrial Mobilization College* as the center of a system for the purpose of training, in all phases of industrial mobilization, Regular and Reserve officers of the armed services, responsible officials of the executive departments and independent offices of the National Government, of the several States, and other important subdivisions of government, and selected civilians of American industry including capital, management, and labor. In the work of this college, particular attention should be paid to the study of the availability and distribution of resources which must be made to meet the needs of the armed services and the essential civilian requirements in war.

Electrical Fire Control

The Development and Function of a New Antiaircraft Director

Halsey A. Frederick

AS the ranges and accuracy of guns have been extended and the speed and altitude of airplanes increased, previously used methods for directing antiaircraft gunfire by means of plotting boards has rapidly become inadequate. First, some mechanical aids to the plotting boards were added, and there are patents on such devices prior to 1914. As early as 1919, we find a patent disclosing the "germs" of an electrical director. Although mechanical aids were used in the first World War, most of the development in antiaircraft fire control has come since that time. Today, the art seems to have spread quite broadly.

A German publication of 1942 gives descriptions, pictures, schematics, theory, etc., on a number of mechanical antiaircraft directors ("Fire Direction Devices for Antiaircraft Guns," by A. Kuhlenkamp, *VDI Zeitschrift,* July 11, 1942: Vol. 66, No. 27-28, pp. 417-429). These included directors by Skoda (Pilsen), three different types of French directors, a German director by Zeiss, a Hungarian and an Italian director, two English directors, and an American director by Sperry.

With the recent great increase in the speed of airplanes and in the height at which they fly, the requirements imposed on an acceptable antiaircraft director have increased tremendously. Today, it may be necessary to aim a gun at a point several miles ahead of the position of the target at the time of fire. The time of flight of the projectile may be as long as thirty seconds.

Not only one but a whole chain of closely interrelated elements must function with great accuracy if consistent and good results are to be achieved. These are:

1. There should be prompt spotting and identification of the target. Preferably, this should be accomplished considerably before the target is within range of the gun; that is, at distances at least as great as ten miles or more.

2. The tracker, which is the device equipped with telescopes to follow and determine the exact course of the target, and the range finder, which is used to measure its distance from the gun, must perform with great precision. These devices collect the prime data on which the computer bases all its predictions.

3. Present-position data collected by the tracker and range finder should be transmitted to the computer continuously, with the least possible error, and instantaneously. Since these devices may be separated by appreciable distances, it is obvious that this should be done electrically.

4. The computer must take data on the present position of the target and from it calculate, continuously and instantaneously, the proper direction in which to point the gun and the proper setting of the time fuze used in the projectile. In performing this function it must make proper corrections for all the characteristics of the gun and the ammunition, the wind, air density, temperature, etc. The data concerning these ballistic characteristics must be determined with great accuracy and precision.

5. Data for pointing the gun and setting the fuze must be transmitted to the gun and fuze setter continuously, instantaneously, and accurately. Also, the gun and fuze setter must always accurately match these instructions.

6. There must be great consistency and uniformity of performance of the gun and its ammunition.

One is also tempted to add to this list an item covering the training, skill, and over-all teamwork of the using troops; and, also, to add an item for the technical skill of the personnel in charge of the setup, calibration, and maintenance of all this interconnected electromechanical equipment, together with an adequate supply of spare parts at the right time and place. Obviously, any errors in any link in this chain limit over-all performance.

In observing a plane to determine its motion and performance, it seems preferable to make all observations from one position rather than to triangulate from two positions separated by some distance. It is, therefore, quite obvious that there are three measurements which are necessary and sufficient to determine the plane's position; namely, the azimuth or horizontal angle measured from some arbitrarily fixed line (usually north-south), the angle of elevation, and the distance to the plane. In other words, we are forced by the nature of the problem to collect data in spherical coördinate form. We thus determine the present position of the plane with respect to the observer by the measurement of two angles and a distance. We must next determine the location of a point in space at which the gun must be aimed in order that the *known* curved path of the shell shall intersect the *assumed* straight path of the plane. We must also determine the time which the shell will require to reach the point of intersection, both to compute how far the plane will travel and to set the time fuze of the shell.

THE first step in the computation is to find the speed and course of the plane. Here we meet an important consideration as a result of which we convert to rectangular coördinates (north-south, east-west, and up-down). If the plane is flying a straight course at constant speed, whether horizontal, climbing, or diving, the three rectangular components of its speed will be constant. The values of these components deduced from the measurements can therefore be averaged over a period of time, and more reliable values can be secured than any instantaneous determination of velocity. Furthermore, the components of velocity thus obtained can be multiplied directly by the time of flight of the shell to give the components of target travel. These components may then be added to the coördinates of present position to give the coördinates of the point where the plane will be when the shell reaches it.

The time of flight of the shell, by which the components of target speed are multiplied, must be the time to the future position of the plane, while the only range that can be measured is that to the present position. The first step is to use the time of flight to the present position and to compute the future position on the basis of that time. This gives a corrected time of flight, which can be used to correct the

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future position again. The process is repeated, with progressively decreasing corrections, until the true value is reached. Actually, it is performed as a continuous operation, and, like the rest of the computations, it is to all intents and purposes instantaneous.

This same determination of time of flight provides the necessary information for setting the fuze on the shell. It remains to compute the point in space at which, as already mentioned, the gun must be aimed in order that the shell may pass through the predicted future position of the plane. This again is a function of ballistic tables which are built into the instrument. Finally, the location of that point must be expressed in spherical coördinates, so as to give the angular settings for the guns.

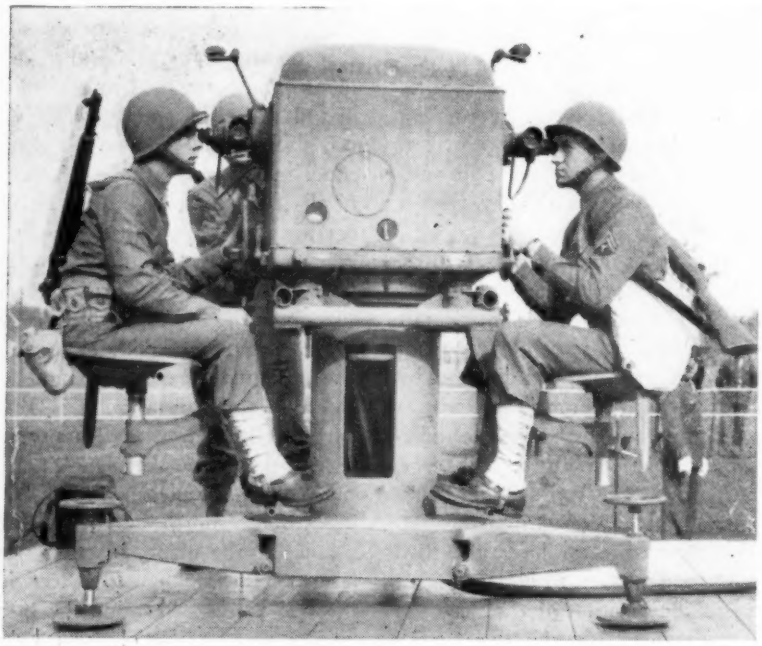

Fig 1. The Tracker Is Operated by Two Men and Determines Azimuth and Elevation of the Target

IT may seem odd that Bell Telephone laboratories should have undertaken this problem which appears remote from telephone research and development. However, experience has indicated that the special skills and techniques of modern communication engineering fit this problem very well. Preliminary suggestions from one of our younger physicists back in 1940 resulted in the general outline of a method of attack on this problem. A memorandum was sent to both the Army and Navy. The Army endorsed the venture, and the National Defense Research Committee agreed to finance it. There followed months of study, conferences with Army experts, and with mathematical and other experts at the laboratories. Not only was it necessary to use numerous devices and techniques previously used in problems of communication, but entirely new devices had to be developed. The whole system had to be worked out and a first model designed and built. When this model was ready, it required careful tests. These steps were successfully taken and the model was delivered to the Army for further study a week before Pearl Harbor.

Since that first model was constructed, a great many changes have been made, but the same basic principles have been followed throughout. In its detailed embodiment, the device has been completely redesigned so that it could be manufactured in quantity and so that it would meet all the practical requirements for use under the rough conditions of service. The director is usually transported in a trailer and consists of four separate units: a tracker, an altitude converter, a computer, and a power supply cabinet. There are also interconnecting cables.

In order to determine the azimuth and elevation of the plane, the two men on the seats of the tracker (Fig. 1) look through telescopes, and, by turning handwheels, one of them rotates the whole tracker and the other elevates and lowers the two telescopes so as to keep the cross hairs in their eyepieces constantly on the target. The two telescopes are rigidly interconnected. The motions may be effected either manually or by electrical motor drives. In this latter case, which is preferred, the rotation of the handwheels varies the rate of drive. To drive faster to the right, the operator turns the wheel farther to the right, and vice versa. With this system, once they get the target on the cross hairs of the telescopes, they need make only small changes to hold it there.

If the computer is used with a range-finding device which reports its data in terms of range rather than height, continuously and in proper electrical form, the altitude converter is not needed and is not used (Fig. 2). However, the optical height finder gives height rather than range data and at short intervals rather than continuously. Settings are reproduced on dials which move each time a new observation is recorded. The operators of the altitude converter, therefore, are provided with motor-driven mechanisms, the speed of which they can adjust in the same manner as the men at the tracker increase or decrease its speed, and they endeavor to keep their two sets of dials together at the times that fresh data are received. In short, the altitude converter takes the height information which it receives at intervals and transmits range data continuously in proper electrical form to the computer.

The computer must be and is able to add, subtract, multiply, divide, differentiate, integrate, and select values of trigonometric functions and empirical data. The character of the information on which it operates must be adjustable by setting various dials by hand at the beginning of the operation. It must do all of this instantaneously, or practically so, and finally pass out the necessary information to the gun.

For any angle of elevation a gun will send its projectile through the air following a particular curved flight. It slows down due to the effects of gravity and friction of the air and curves to the right, somewhat like an incurve in baseball, due to the spin from the rifling. The character of the curve followed will, of course, be different for every different elevation of the gun. It will also be different if the gun is new and very little worn so that the muzzle velocity is relatively large compared with that of an older gun which has been worn from much firing.

The curve followed by the projectile is also affected by the density of the air and by wind in any direction. All these must be observed and proper corrections put in by dials which are set by hand. Another important correction already mentioned is due to the fact that the guns may be some distance

away from the point where observations are made. These parallax corrections are introduced into the computer by means of dials which are set by hand at the time the battery is emplaced.

The proper fuze setting depends on the time of flight of the projectile as modified by all the factors mentioned above. This information is transmitted to the fuze setter. Another correction which affects fuze calculations is so-called "dead time." This is the time which always elapses after the fuze has been set and before the shell can be put into the gun, the breech closed and the gun actually fired. It must be determined for the particular battery and crew and this value set up on the proper dial on the computer. Four additional dials are also provided, known as "spots." These make it possible for the battery commander, as a result of experience, arbitrarily to introduce corrections or biasing changes in the computer; one affecting azimuth; one, elevation; one, range; and one, fuze.

FIG. 2. THE COMPUTER AND ALTITUDE CONVERTER, ABOVE, ARE CONNECTED BY CABLES TO THE TRACKER, HEIGHT FINDER, AND GUNS

The ideal case assumes that the plane is flying a straight course at constant speed. This assumption is never met with precision. Even if it were, the men operating the tracker and other instruments could not do a perfect job. As a result of these factors, the data on which the computer operates do not represent the exact present position of the plane at each instant. Unless corrective means are used, the derived rates of motion tend to vary, introducing errors which are much greater than the errors in present-position data. The electrical computer averages data fed to it and uses the most probable values of the rates in making its prediction. This factor adds greatly to the accuracy of the resultant predictions.

IT is extremely important that the men operating the battery know when the data are such that they can shoot with reasonable anticipation of hitting the target. There is a high probability that this is true when the indicated rates or velocities of the target along the three component directions are constant. Indicating instruments are provided which show when such constancy exists so that the battery commander can tell when firing should start.

After a first model of such a device as this has been found to meet its basic requirements, the task is then one of putting the design in condition for quantity production. Such a task frequently far exceeds, in man-hours of time and in cost, the successful completion of the first working model. Such was the case with this director.

After production designs were worked out, preproduction models of numerous components were studied, tested, and improved. Then preproduction models of complete directors were made. These, in turn, were tested for mechanical ruggedness, exposure to humidity, rain, dust, and to temperatures from minus 40 degrees to 150 degrees above Fahrenheit. They were given vibration, shock, and other rough-treatment tests. Starting at the time that the original design for manufacture was being worked out, repair methods were studied, special tools for repair of components in the field were designed and produced, and detailed instructions were prepared for field operation, maintenance, repair, and complete rebuilding of directors as a guide for mechanics.

It is our experience that the maintenance of an electrical device is somewhat simpler than that of a mechanical device. Where numerous bearings, antibacklash gears, cams, etc., are involved, great mechanical skill is required not only in manufacture and adjustment but also in performing any needed repair or maintenance operations. The whole device is so intimately and closely tied together mechanically that it is very difficult to divide it into subassemblies which can be taken out as a whole and replaced. Therefore, if parts are bent or strained, it is hard to repair them. It is often necessary to rely on the judgment of a very highly skilled mechanic who depends on the "feel" of the parts to judge whether they are all right.

With electrical equipment it is relatively easy to arrange the design so that it consists of subassemblies on which the mechanical interconnection is not particularly critical and the electrical connections are made by wires. It is not necessary even to keep them all in the same package, since interconnecting cables are both simple and satisfactory. Many electrical parts, such as condensers, coils, fixed resistors, etc., are placed in sealed cans so that the man in the field cannot repair them. If they develop defects he merely replaces them. Experience has indicated that in such equipment, troubles seldom develop and little servicing is needed to keep the instruments operating efficiently.

From the point of view of quantity manufacture and field maintenance, with all the problems of spare parts, training, etc., design changes are undesirable; however, changes are inevitable. The beauty of electrical design is that, because it can be broken down easily and completely into component elements, changes can be introduced with relatively little disturbance of other parts of the system. This director is a dynamic device. It has changed, and it should continue to change, to meet new-found needs, requirements, and possibilities. Whole components may be replaced by new and better units. The fact that this can be done is a basic advantage in its principle of operation.

Japanese Small Arms

Types and Characteristics of Rifles, Pistols, and Machine Guns

Capt. Melvin M. Johnson, Jr., U.S.M.C.R.

JAPANESE small arms are quite conventional and somewhat more standardized than their aircraft weapons. The latter are very much copies of a motley variety of European and U. S. guns, including the Lewis, Vickers, Browning, Breda, Oerlikon, and a modified Nambu.

The most notable items on the small-arms list are the Type 96 and 99 light machine guns or "autorifles" (Fig. 7), the modernized 7.7-mm. Arisaka (Fig. 2), which is an M1905 Mauser-patterned shoulder rifle, the heavy air-cooled Hotchkiss-pirated Type 92 7.7-mm. machine gun (Fig. 4), and the older Nambu M1922 light machine gun (Fig. 1).

A most peculiar situation obtains with Japanese small-arms ammunition. The earlier 6.5-mm. 139-grain semirimmed case load, developing 2,400 foot-seconds' muzzle velocity, is being replaced by the 7.7-mm., of which there are 3 types and several loads; namely, the rim type, having a 174-grain bullet with a muzzle velocity of 2,500 foot-seconds, identical with British .303 service ammunition; the semirimmed type loaded with a 205-grain boattailed bullet with a muzzle velocity of 2,200 foot-seconds in the 30-inch barrel of the Type 92 heavy machine gun; and the Arisaka and Type 99 load which is rimless, the 184-grain flat-base bullet developing 2,300 foot-seconds in the 21-inch barrel of the light machine gun.

FIG. 1. THE 6.5-MM. NAMBU LIGHT MACHINE GUN, M1922

Another peculiarity of some Jap weapons is seen in the cartridge oiler mounted on the Hotchkiss Type 92 and Nambu M1922 machine guns. This oiler is needed due to the harsh primary or initial extraction. This technical weakness of these two earlier-type Jap weapons has been apparently eliminated in the later-designed Type 96 (6.5-mm.) and Type 99 (7.7-mm.) machine guns.

The Japs, therefore, have a hand-operated rifle, two light machine guns, and one heavy machine gun. They have actually four types of ammunition, virtually not interchangeable between certain groups of weapons. Therefore, the obvious question arises: How do they compare with United Nations' weapons?

The 9-pound Jap Arisaka rifle in the earlier caliber, .256-inch or 6.5-mm., with a 30-inch barrel gives no flash or smoke. It is tough to spot a sniper so armed. The .256 load has little recoil, but, except for the lack of flash and smoke, the Arisaka is quite inferior in accuracy and power to our M1903 Springfield. The .303-inch or 7.7-mm. 8.7-pound Arisaka is in many respects a better Jap weapon. It has a 23-inch modern Mauser-type barrel, does not generally have the earlier-type rattling tin dirt cover around the bolt, and shoots a better cartridge having greater energy, penetration, stability, and wind-bucking characteristics. The 184-grain bullet is 34 grains heavier than our 150-grain M2, although the muzzle velocity is about 300-400 foot-seconds less. While our trajectory is slightly flatter up to 500-600 yards, the difference is probably not very great. There is certainly nothing "sissy" about the 7.7-mm. 184-grain 2,300-foot-second load.

We have, of course, the Garand or M1 semiautomatic rifle with 8-shot clip, two rounds more than an Arisaka or U.S. M1903 with one in the chamber and five in the magazine. The Japs do not have a semiautomatic in service, but probably they have used some of our own against us on occasion.

Our rifles and ammunition are more inherently accurate and better made than the Jap arms, and the Jap soldier on the whole is not as good a marksman. Nevertheless, the Japs are clever in the jungle and take every advantage of cover to shoot at favorable ranges. By such tactics they have unfortunately been successful on occasion with their light machine guns. Advantageously placed, these bipod-mounted 20-pound full-automatic shoulder guns with 30-shot feed capacity have proved quite effective.

THE M1922 Nambu is of 6.5 mm. and originally utilized a unique hopper feed system by which six 5-shot Arisaka rifle clips could be placed in the hopper and fed from the clips into the chamber. Being actually a 22-pound modified Hotchkiss light type, somewhat like the earlier French and British guns and a distant "cousin" of the U.S. Benét-Mercié, M1909, the Nambu lent itself more recently to adaptation of the older strip feed. Marine combat reports tell of Jap snipers in trees with Nambus loaded and fed by 30-shot cardboard strips.

Depending upon an oiler to insure proper extraction of the empty cases, the gas-operated Nambu cannot be compared very favorably with corresponding U. S. arms such as the Browning M1918A2. Such weapons require a relatively slow camming motion in the breech action to insure loosening the case during initial extraction, or what is sometimes called "slow extraction." The case clings tightly to the chamber wall; therefore, means are provided for the operating or piston rod to commence opening the breech at a relatively slow initial speed. This slow extraction is accomplished in the British Bren and our Browning automatic rifle. The Japs missed the point in the Nambu as well as in the heavy Type 92. Thus, if the oiler on these two Jap arms is out of order or dry, serious jams due to torn cartridge cases may result.

But in the Types 96 and 99, Japanese ordnance experts grasped the idea of slow extraction and provided an angular

Captain Johnson, of the U. S. Marine Corps Reserve (inactive), is the inventor of the Johnson light machine gun.

cam on the lock to ease the initial rearward movement of the breechblock. Type 99 with 7.7-mm. rimless ammunition is the latest and best Jap machine gun. It weighs 20 pounds with bipod, holds 30 rounds in a topside-mounted magazine of the Bren detachable-box type, and fires full automatic only at 700 shots a minute. There is no cartridge oiler. A handle is provided for easy carrying and, with shoulder sling, for firing offhand or kneeling.

The Type 99 is gas-operated. Except for the somewhat novel rectangular ring-type lock, vertically positioned in the receiver slots for engagement in the breechblock recess when cammed upward by the operating shaft, the action is not unlike the Czech Z. B. and British-modified Bren. Some features resemble the M1929 Chatellerault, the pre-1940 French light machine gun.

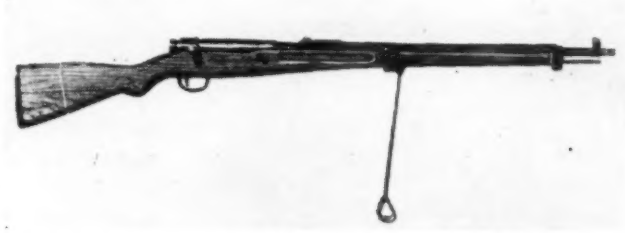

FIG. 2. THE 7.7-MM. ARISAKA RIFLE WITH MONOPOD

Like all the light machine guns of the post-1919 development era, the Jap model is cocked open, firing on the closing stroke. The ejection port is at all times covered by a spring-actuated flap which opens only when the lever-type ejector, similar to earlier Nambu Jap models, forces the case out past the cover. A hinged cover also protects the magazine aperture on top of the breech when the magazine is not in place. The ejector also is covered by a sheet-metal casing for the purpose of keeping out dirt, sand, and mud.

As with the Type 92 and Nambu, the cocking handle of Type 99 is on the left. The sights, as with the Z. B., Bren, and M1929 Chatellerault, are offset on the left side (the Nambu sights are on the right, the Nambu stock being offset). The Type 99 rear sight is virtually identical with the British Bren but, unlike all other European weapons and apparently copying us, there is windage adjustment in the rear sight. The Type 99 is very simple, neat, and easy to field strip and clean. Latest models have a removable-barrel feature. A loader to fill the box magazines is provided, and recent models have been found with a rather well-made medium-power telescope sight. Provision for mounting the rifle bayonet has been included and a flash hider can be attached to the 21-inch barrel.

Indeed, the Type 99 with 184-grain .303-inch bullet at 2,300 foot-seconds in rimless case is very respectable, probably quite reliable, and in many respects simpler and neater than some corresponding United Nations' arms. There is, of course, nothing unusually novel or sensational about this gun, which is generally a less bedecked, less gaudy counterpart of the British and Australian Bren gun, caliber .303.

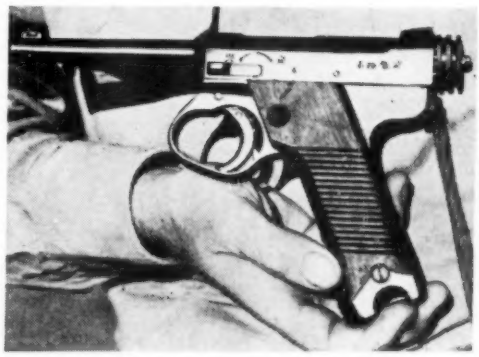

FIG. 3. THE 8-MM. PISTOL, TYPE 14

THE Japanese counterpart of the United States heavy Browning water-cooled belt-fed machine gun is a modified Hotchkiss of the air-cooled type, fed by strips holding thirty rounds and having an unusually heavy air-cooled barrel with large radiating rings to facilitate cooling.

This Hotchkiss has been in Japanese service for many years, and is the result of modifications made from the original weapon which the Japanese used in the war with Russia earlier in the century. Originally chambered for 6.5-mm. ammunition in the pre-1914 model, the later design known as Type 92 is chambered for the 7.7-mm. Both the 6.5-mm. and the 7.7-mm. ammunition issued for the Type 92 gun are of the semirimless type. This undoubtedly causes Japanese troops considerable confusion because the semirimless 7.7 will not function in the rimless case designed for the Type 99 and 7.7-mm. Arisaka squad weapons. As indicated above in another connection, the Type 92 fires a 205-grain boattailed bullet at approximately 2,200 foot-seconds' muzzle velocity. This load should give reasonably good performance at quite long range, due chiefly to the heavy bullet and the boattail.

The Type 92 weighs approximately 65 pounds, or nearly 30 pounds more than our heavy Browning. The mount weighs approximately 55 pounds, somewhat more than our 1917 heavy Browning model. The Type 92 uses a 30-inch barrel and is about 45 inches over-all. Provision is made on the mount for traversing- and elevating-gear movements. A small telescopic type sight is usually mounted on the left side of the receiver.

The action of the Type 92 indicates the source of the Nambu M1922 action, for the two guns are very similar. Like the Nambu, the gas-operated Type 92 requires an oiler in order to facilitate proper extraction. Inasmuch as the original parent French heavy Hotchkiss does not require oiling the ammunition, it seems strange that the Japanese should have had such difficulty in successfully copying that mechanical feature. Nevertheless, they have apparently failed to do so in this weapon. Firing at a cyclic rate of slightly over 500 rounds a minute, or about the same rate as the M1917 heavy Browning, the Jap 7.7-mm. Hotchkiss is fed from the left by strips and is cocked with an open bolt.

This heavy weapon is, of course, especially useful for Japanese defensive operations and is commonly found in emplacements. Personnel who get caught in its beaten zone are indeed unfortunate, but it is understood that an antidote for the Type 92 is to keep just off the fixed line of its fire, for the weapon is not very flexible tactically. Flexible-fire missions are no doubt left to the light machine guns, which are, of course, better suited. The Type 92 is an unusually clumsy and very obsolete type of weapon. Mechanically it cannot be compared to our Browning, and it is not even a very good imitation of the original French M1917 Hotchkiss gun such as that used by our forces in the A.E.F. of World War I. Despite this, however, in many instances it is probably a very effective weapon. It appears to shoot a very close pattern due in large measure to its very heavy barrel and great weight. To what extent it is troubled with stoppages is not definitely known, but it is estimated that it would not compare in

mechanical performance with our Browning M1917 or 1919A4 weapons. Nevertheless, when our forces go against Japanese pillboxes and emplacements such as those found on Tarawa, it should not be conceived by any one that the Type 92 is not a most deadly weapon. Intense bursts of its heavy 205-grain boattailed bullets at any average machine-gun range are regrettably effective.

The Japanese have two types of small, light automatic

Fig. 4. The Japanese 7.7-mm. Heavy Machine Gun, Type 92

service pistols of the 8-mm. type (Fig. 3) having bullets slightly over 100 grains with a relatively slow velocity of 860 feet a second at the muzzle. The Nambu 8-mm. 1925 type has been changed slightly in a new model. Essentially, the Nambu resembles the German Luger but has a different locking system. It is of the short-recoil type. The Japanese technicians imposed some of their own ideas in generally copying a European pistol, following the same procedure as in the development of the light machine gun.

THERE is nothing exceptional about the Jap pistol; it is not nearly as effective to knock down personnel at pistol ranges as our .45 Colt automatic. It has been rather well demonstrated that a light low-velocity pistol bullet is not dependable. It is therefore necessary to have either a high muzzle velocity, often obtained with great difficulty in order to make effective a bullet of around 100 grains, or otherwise to go up to 200 grains as with the .45 Colt automatic in order to get knockdown power.

Since as a nation the Japanese are fighting in one aspect to build up their economic power, they have inevitably entered the war with armament inferior from a technical point of view in many respects to that of the United States or Great Britain. They are inclined to copy to a considerable extent, and, having no compunctions about the varieties of models or types of ammunition, they have imitated the Lewis, Vickers, Browning, and Bren guns. Since the Chinese have largely used modifications of the Czechoslovakian Z. B. light machine gun of 7.9 mm. (the German service caliber), the Japanese have no doubt picked up many of these guns as well as large quantities of captured British Bren guns in caliber .303, the Bren being generally a modification of the Czech Z. B. Since the Japanese use the Lewis gun in aircraft to some extent, they have already employed the .303 rim-type British cartridge. This was probably the basis upon which they initiated the so-called Japanese 7.7-mm.

A subject of great speculation amongst those interested in small arms naturally relates to the mystery of the three types of Japanese 7.7 cartridges; namely, the rimmed, semirimmed (Fig. 6), and rimless. Why did the Japs inflict this nightmare of confused supply upon their infantry units?

Inasmuch as the Japanese air forces started off with Lewis guns which were particularly adapted for the British rimmed ammunition, they probably arrived at a decision to give the infantry a heavier small-arms bullet after observing the inadequacy in many instances of the light caliber .25 earlier service ammunition. In their Hotchkiss gun they have always had difficulty with extraction. Since the Hotchkiss gun was developed for the semirimmed 6.5, it is probable that they determined to give the new model every possible advantage in extraction. Since it is of the strip-fed type, the semirim in no way interferes with feeding.

On the other hand, the semirimmed case facilitates extraction and gives more extractor bearing. This probably resulted in their adoption of the semirimmed 7.7-mm. In the meantime, they had observed the effects of boattailed bullets for long-range machine-gun barrages as a result of experience in the first World War. Moreover, they saw the United States going to the M1 boattailed bullet in 1926. So they developed a heavy boattailed bullet having characteristics quite similar to those of the French 8-mm. Balle D which had approximately a 200-grain boattailed bullet with a velocity of about 2,300 foot-seconds.

Next, the Japanese wanted to provide a cartridge to improve the characteristics of their shoulder rifle and their new light machine gun. Since they no doubt had some difficulty with the semirim of the 6.5-mm. (Fig. 5) in their Arisaka rifle with its Mauser-type magazine feed system, it was natural for them to favor a rimless case for the new

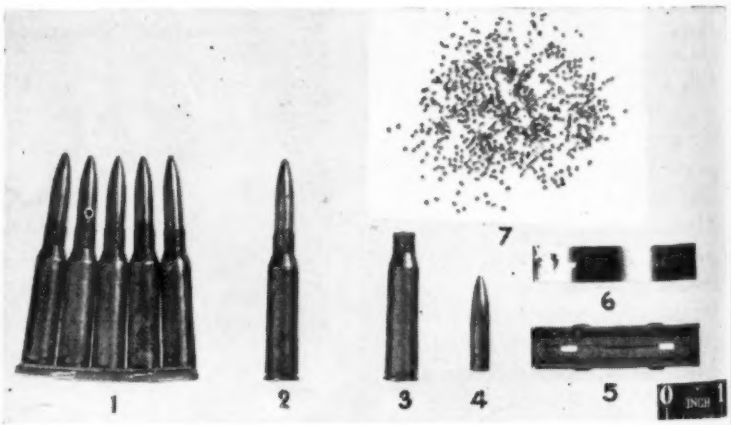

Fig. 5. Japanese 6.5-mm. Rifle Cartridges, M1905

1. Clip of five; 2. Single cartridge; 3. Case; 4. Bullet; 5. Clip; 6. Clip spring; 7. Propellant.

modernized Arisaka. Having observed the great difficulty which the British encountered in using a rimmed cartridge in the Bren, in contrast to the 7.9-mm. rimless for which the parent Z. B. gun was originally designed, they no doubt determined to give their new light machine gun the advantage of feeding rimless ammunition in its Bren-type

magazine. Accordingly, they no doubt developed the 7.7 rimless load.

ACTUALLY, the 184-grain Jap bullet is ten grains heavier than the British service type. While Japanese ammunition undoubtedly lacks a great many technical refinements in detail which are enjoyed by forces of the United States and Great Britain, the characteristics of the resulting 7.7 cartridge are unquestionably quite favorable. The deviation due to the force of the wind upon relatively lightweight bullets is much greater than upon heavier bullets. The 184-grain bullet will maintain its velocity fairly well along combat ranges, giving it quite an effective terminal or striking velocity. Its penetration will be correspondingly good as will its hitting power. The heavy bullet is not easily upset by brush when fired in the jungle.

The angles of elevation for this ammunition are probably quite similar to that of the British service .303 Mark VII. Compared to our .30M2, the 7.7 trajectory is probably just a little higher, and for practical purposes the difference in the angles of elevation for combat ranges in hundreds of yards is probably slightly greater. Whereas the angle of elevation in the .30M2 for 300 yards is approximately 8 minutes, the Japanese probably require 12 minutes. At 600 yards we require approximately 21 minutes of angle with the .30M2 and the Japanese require about 27 minutes of angle. The Jap bullet is probably affected less by the wind than our M2, however.

Thus, the Japanese have apparently realized they could not develop some radical improvement in muzzle velocity sufficient to warrant retaining a relatively lightweight bullet. Accordingly they have gone from a relatively lightweight small caliber to a relatively larger caliber and heavier weight. It must be confessed that this is quite a practical approach to the problem. While they have done nothing remarkable and while their ammunition is no different from that used for many years in European services, they nevertheless have a very effective small-arms cartridge.

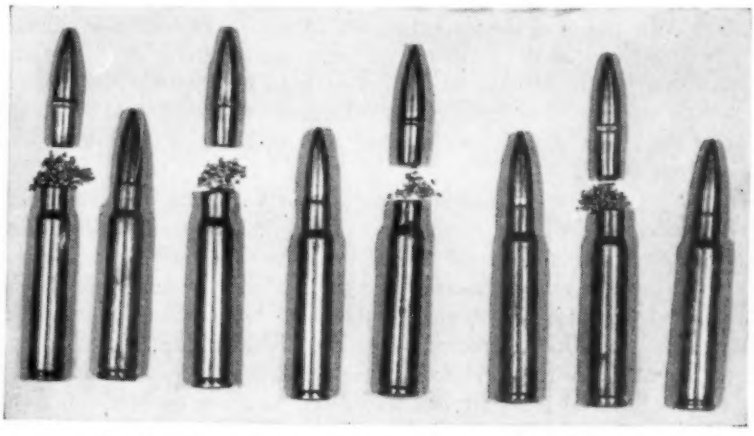

FIG. 6. JAPANESE 7.7-MM. SEMIRIMMED AMMUNITION

Left to right in disassembled and assembled rounds: Black-band armor-piercing; Brown-band semiarmor-piercing; Red-band ball; Green-band tracer.

The confusion which must obtain when the Japs are running around with Arisakas, Type 96 and Type 99 light machine guns, and Type 92 heavy machine guns—in their various calibers—can be better imagined than described. However, most of the heavy machine-gun ammunition is already packed in strips so it would not usually be mistaken for the rimless type which is probably packed in the Arisaka 5-shot Mauser-type clips. Since the light machine gun has a loading device with a hopper for insertion of Arisaka clips which are then worked into the 30-shot-box magazine, it is not necessarily likely that the rimless ammunition would be mistaken for that used in the Hotchkiss. On the other hand, it is not easy to tell the difference between the semirimmed and rimless 7.7. You can feel it with your fingers, but you have to be careful in making the selection. There is just enough difference to cause a supreme percentage of malfunctions, for it is possible to ram one in the wrong gun and fire it off.

FIG. 7. THE JAPANESE 7.7-MM. LIGHT MACHINE GUN, TYPE 99

It is not unlikely that as the war goes on the Japanese will concentrate more and more upon the Type 99 light machine gun and the Arisaka rifle with the rimless ammunition. Those two weapons, of course, are the basic squad small arms, together with grenade throwers and light mortars. It was observed in their earlier China campaign that the Japanese 8-man squad included one light machine gun and seven riflemen. Recent reports indicate that in many instances the Japanese are putting two light machine guns in the 8-man squad. This is probably particulary the case where the Type 99 is the gun. Since the Japanese are not good individual riflemen, this increased distribution of the full-automatic light machine gun is quite a natural solution.

THE workmanship and materials used in Japanese small arms vary, so far as observation has disclosed in random examinations. The recent 7.7-mm. model Arisaka appears to be quite a well-made piece, although not comparable to the high quality of American-made equipment. The Type 99 is also a well-made piece and has quite good finish. Reports from the combat area indicate considerable interest and amazement on the part of our forces at the excellent antirust treatment which the Japanese have given their metalwork.

In conclusion, it is perfectly obvious that Japanese small arms are not on the whole as good as our own. The Japanese are not as advanced in ordnance development and mass production, and this is reflected in their small arms and the quality of their workmanship.

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JULY-AUGUST, 1944

Month by Month

Alaska—Key to Air Strategy.—"The nation which holds Alaska holds strategic control of the airways of the world." Thus spoke Brig. Gen. William ("Billy") Mitchell, Chief of the Army Air Corps, in 1925. For this reason, our now firm hold on the Aleutians presages major air operations in this vital area.

The Aleutian chain projects to within 500 miles of the Jap base of Paramushiru, already frequently raided by our aircraft. Paramushiru is the last island in the Kurile group, just north of the main Japanese Island group. Future attacks will eventually hit all the Kuriles and extend to the more thickly populated islands of Japan proper.

The United States is strongly established in Alaska, and on Amchitka, Attu, Adak, and Kiska in the Aleutians. We are there for keeps. Local aviation-ordnance problems have been solved.

Ordnance combat troops in the Aleutians store, maintain, and test all types of ammunition. They deliver completely assembled bombs and belted machine-gun ammunition to all airplanes of the combat squadrons. They inspect and repair all guns and cannon installed in combat planes. These operations must be carried on under the most adverse weather conditions. It rains almost continuously the greater part of the year. Climatic conditions are particularly severe during the winter season which extends from September through April.

Ammunition storage is extremely difficult. For the last thousand miles on the Aleutian chain there are no trees—hence no local wood supply for building storage facilities for bombs, bombardment flares, fuzes, pyrotechnics, and small-arms and cannon ammunition. The islands are of rock formation, but any level area is covered with a spongy tundra or boggy muskeg which may extend from a depth of two to twenty feet. The tendency of heavy ammunition stacks to sink in the moist tundra makes the storage problem especially difficult. In servicing bombs to aircraft, because of the difficulties of transportation across the tundra with wheeled vehicles, it is necessary that an additional ammunition area be established near the runway.

An ideal site for proof work and, particularly, for testing demolition bombs over water has been found at Knik Arm in Alaska where there is a phenomenal tide. Here there is a depth of twelve to fifteen feet of water upon which bombs can be released at high tide. At ebb tide, an area of approximately three-quarters of a mile of bottom is exposed, so that any unexploded bombs may be inspected to determine the cause of explosion failure as the bomb lies in the position in which it came to rest. Ordnance observers watch bomb performances from a slit trench near the front of a high bluff overlooking this unique Alaskan proving ground.

Paper for Protection.—The "age of steel," this period of modern industrial development, is fast being rivaled by the "age of paper," and in some instances in this war steel has been found usable at the front only because it had been protected by paper. When the Industry-Ordnance team mastered the science of production, the next phase was to master the science of protection. The paper industry stepped into this breach so successfully that now there is scarcely a material for war going to the fighting fronts without the protection of paper—often in a form that is becoming known as "Ordnance wrap."

So varied are the war uses to which paper is being put that it would be difficult to list them all, but one single instance of the importance of paper as a protection to delicate and costly weapons has been made public by Brig. Gen. E. E. MacMorland, chief of the Field Service Maintenance Branch of the Ordnance Department. Speaking about a recent amphibious landing by troops, General MacMorland said:

"I was watching some of our Ordnance guns being unloaded. One of the pieces being hoisted from a ship was a mechanism used to direct antiaircraft gunfire. These directors weigh a quarter of a ton, but they are so precise and, in a sense, so delicate that they have to be manufactured in air-conditioned rooms where the slightest flake of dust or hint of rust is kept from their watchlike interiors. Their heavy metal parts are balanced nicely to move on precision gears, to calculate, faster than any human brain, the height, speed, and direction of flight of enemy planes, and to direct the fire of our great guns to the precise spot where the flight of the plane crosses the path of the shell.

"As I watched, something went wrong with the hoist, and I saw this ¼-ton precision instrument crash. By all rights that director should have been done for. But we had the crate opened there and then. Inside we found the mechanism undamaged. The director had been cushioned in paper. No ordinary paper, to be sure, but a cushioning device that Ordnance Field Service, with the aid of industry, had developed.

After trying steel spiral springs and wood cantilever springs, we hit on special built-up corrugated pads wrapped and sealed in heavy waterproof paper. These pads are cheap, easy to assemble, and they protect from damage the instruments it is so essential to deliver in perfect condition to the troops overseas."

Sometimes these heavy, delicate machines have to be thrown off into the surf or onto the sands of lonely islands in the Pacific; they must lie exposed to corrosive salt air and rain until the soldiers can make other provision for them. We do not fight only where there are docks and modern cranes and dry warehouses. Our fighting implements are the last word of modern science, but they must be carried through the jungles or stored in steaming hot tropical caves or piled upon the icy shores of arctic seas or buried beneath desert sands. In such cases the science of protection is as important as the science of production.

The Ordnance Department is using great amounts of acid-free greaseproof wrapping papers successfully developed to protect metal surfaces from corrosion. The use of this type of paper alone equals from 12,000,000 to 15,000,000 square yards a month—enough to cover 37,000 acres in a year. Other Army forces and the Navy are using additional amounts. Two years ago, the paper industry produced something like 16,000 tons of waterproof paper; today, it is producing more than 200,000 tons.

The Ordnance Department has saved steel, critical woods, and most critical ship space through new uses for paper. A new white tissue paper made by the American paper industry has replaced the traditional imported paper for cleaning telescopes, range finders, and other optical instruments. Paper for targets, tags, packing lists—uses are endless. Ordnance is now using paper for the bands around bombs to protect them until they are loaded into planes ready for the trip to Berlin. These paper bands in tests at the Aberdeen Proving Ground proved to be stronger than steel.

Soldier-Maintenance Cost Reduced.—The cost of initially clothing and equipping a soldier and feeding him for a year in the continental United States is $36 lower than it was a year ago. Included are the costs of all food and clothing issued to the soldier as well as many items of personal equipment, but not arms, ammunition, medical supplies, gas masks and certain other items which vary according to the soldier's assignments.

To maintain the average soldier in continental United States during his first year of service the Quartermaster Corps spends $215.35 for his food, $173.70 for his clothing, $44.70 for his individual equipment, and $31.31 for his barrack equipment—a total of $465.06. The cost of feeding a soldier is now 59 cents a day, 3 cents a day less than a year ago.

A year ago food cost was $226.30; clothing, $190.23; individual equipment, $57.42; and barrack equipment, $27.11—a total of $501.06. Thus, the Quartermaster Corps now spends $10.95 less for food, $16.53 less for clothing, and $12.72 less for individual equipment, but $4.20 more for barrack equipment.

Savings on items of clothing and personal equipment amount, in most instances, to only a few cents each. A web waist belt, for example, costs 21 cents today, compared with 23 cents a year ago; a helmet liner, $1.48 against $1.64 a year ago; leggings, 90 cents a pair against 96 cents last year; and overcoats cost $13.35 instead of $15.50. There are several items of clothing, however, that cost more.

Maintenance costs for clothing and personal equipment likewise dropped. Maintenance of clothing is now $70.95 against $75.37 last year, and personal equipment $9.65 against $12.65 last year. Maintenance for barrack equipment advanced from $4.20 to $5.63 at present.

Announcing *Firepower*, The Ordnanceman's Journal.—The Army Ordnance Association is proud to announce a new bimonthly publication in the Ordnance field. *Firepower*, designed as a running mate to ARMY ORDNANCE, will be distributed to all members of the Association and will appear in alternate months. As ARMY ORDNANCE expresses the technical and industrial side of the Ordnance picture, *Firepower*, replete with color and chock-full of illustrations, treats more especially of the problems of Ordnancemen in the field.

The first issue, out June 1st, featured the battle diary of an Ordnance company in North Africa, a story on Ordnance service in the Marine Corps, and an account of an Ordnance beach landing under fire.

Chief Warrant Officer Will Eisner, of the Ordnance Department, is technical adviser to the new publication, and Staff Sgt. Robert Lamar is associate adviser. The Chief of Ordnance has encouraged all Ordnance personnel to contribute articles, and it is hoped that many will respond. Accepted manuscripts are paid for, and opinions and suggestions are welcome!

Alden Prize Essay.—Col. Herbert W. Alden, president of the Detroit Post of the Army Ordnance Association, Army Ordnance Medalist for 1942, and director of engineering, the Timken-Detroit Axle Company, is the recipient of new and unusual honors. An annual prize essay contest has been inaugurated which will bear his name and will carry with it an annual prize of one hundred dollars for the winning essay.

The board of directors of the Timken-Detroit Axle Company at a special meeting held April 28, 1944, presented a gift of $5,000 to the Army Ordnance Association to be held in trust for an annual award of a prize to be known as the Alden Essay Prize. The principal sum will be invested by the officers and directors of the Association and from the proceeds thereof one hundred dollars will be awarded annually "for the best essay on some military, industrial, technical, or scientific subject having to do with the design, procurement, production, supply, or maintenance of ordnance equipment for the armed forces of the United States."

The subject of the essay will be decided by a committee of members of the Association. The contest will be open to all junior officers—*i.e.*, of the grade of captain and below—and all noncommissioned officers and enlisted men of the Ordnance Department of the Army, Regular and Reserve. The winner of each annual contest will be decided by a committee of judges to be appointed by the president of the Association, and the prize-winning essay will be published in ARMY ORDNANCE and also in *Firepower*, the new bimonthly journal of the Association.

The essay foundation is a fitting tribute to Colonel Alden who so richly deserves the highest Ordnance acclaim.

Association Affairs

Empire Post

THERE were 1,037 members and guests present at a testimonial meeting of the Empire Post, formerly the Rochester Post of the Army Ordnance Association, in honor of Maj. Gen. L. H. Campbell, Jr., Chief of Ordnance, on May 18, 1944, in the grand ball room of the Hotel Statler, Buffalo. This was the largest dinner-meeting ever held in the city of Buffalo, and it commemorated the twenty-sixth anniversary of the establishment of the Ordnance district system. General Campbell, in his address, paid high tribute to the work of the Ordnance districts during the past twenty-six years. His remarks are published in full on page 81 of this issue.

Ralph F. Peo of Buffalo was chairman of the general committee and presided at the dinner. Following the National Anthem, the invocation was given by Rev. William Thomas Heath, rector of the Trinity Episcopal Church, Buffalo. Mr. Peo then presented the toastmaster, Frank J. Smith of Rochester, president of the Empire Post. An address of welcome was given by Col. William Kelly, president, Niagara Hudson Power Corporation, a director of the local Post. Col. Frank J. Atwood, chief of the Rochester Ordnance District, introduced General Campbell. Following General Campbell's address, the meeting was brought to a close by the première showing of the War Department motion picture "How Good Is Your Gun?" Col. L. A. Codd, executive assistant to the Chief of Ordnance, also addressed the meeting, preceding General Campbell's address, on the aims and purposes of the Army Ordnance Association.

Officers of the Empire Post who assisted in arrangements for the meeting in addition to Mr. Smith, Colonel Atwood, and Colonel Kelly were: Edward A. Halbleib, vice-president; Erwin R. Davenport, treasurer, and the following members of the board of directors: J. K. Baylis, James E. Gleason, Carl S. Hallauer, Fred F. Hickey, Thomas L. Lee, David W. Sowers, and Albert F. Sulzer.

The following members served on the dinner committee representing the Buffalo contingent: Howard O. Babcock, William M. Baldwin, Mr. Baylis, Mark A. Daly, Robert E. Dillon, Morris S. Evans, Theodore C. Fedders, Colonel Kelly, D. P. Murphy, John R. Oishei, Karr Parker, Mr. Peo, Leslie G. Taylor, William E. Van Horn, George B. Walbridge, Ray P. Whitman, Keith Williams, and Burdette S. Wright.

Also on the dinner committee were: C. E. Norquist, Jamestown; Martin F. Hilfinger, Syracuse; Mr. Hickey, Utica; Col. Ledyard Cogswell, Jr., Albany; C. A. Kirk, Endicott, and W. L. McGrath, Elmira.

Cincinnati Post

THE annual dinner meeting of the Cincinnati Post was held on May 13th in the Hall of Mirrors, Netherland Plaza Hotel, Cincinnati, Ohio, and was attended by approximately 625 members and their guests.

The program was opened with a brief address of welcome by Col. J. C. Shouvlin, chief of the Cincinnati Ordnance District, and secretary of the Cincinnati Post. His address was followed by the reading of the president's report for the past year by C. W. DuPuis, vice-president of the Post. Frederick V. Geier, Post president, was unavoidably absent from the meeting.

The president's report showed that during the past year and a half the Post's endowment committee, under the chairmanship of J. B. Doan, had secured contributions in the amount of more than $42,000 from firms in the Cincinnati District for the Army Ordnance Association Endowment Fund. It also disclosed that within recent weeks over 2,200 new members have joined the Cincinnati Post, raising the membership to 3,450. Louis Polk, general chairman of the Post's membership committee, together with state chairmen R. K. Brodie for Ohio, Homer Capehart for Indiana, Rudy Fritsch for Kentucky, and A. J. Moses for Tennessee, led this outstandingly successful campaign. Great credit for this success is also due to the fine work of the local chairmen. The enthusiasm and untiring efforts of Colonel Shouvlin and Mr. Polk in this membership campaign, as in the general welfare of the Post, are known and gratefully appreciated by the membership.

Maj. Gen. Thomas J. Hayes, chief of the Ordnance Industrial Division, was the principal speaker of the evening. His remarks in part follow: "Industry in and around Cincinnati has always represented not only the metropolis of the machine-tool world, but also the ingenuity and the vision which have made American manufacturing processes supreme. Your contributions to our peacetime economy made America the leading mass-producer in the world. The same kind of ingenuity applied swiftly to the dreadful business of war has been the savior of our noble allies and has signed the death warrant of our enemies.

"The job that you have done—and the job that you are doing—is superb. News from Europe, from Asia, from the Atlantic, and from the Pacific is the best proof that I can cite of the fine record you are making—a record of which any one can be proud. It is a record which is particularly gratifying to me because it is being made by the people with whom I was born and brought up. You have met the emergency. In addition to providing your share—and more—of your sons and daughters who are now serving in our fighting forces, you have been preëminent in backing them up with the tools that they need to get the job done. You made the machines which made the munitions—the standard machine tools, the special-purpose machinery, the jigs and fixtures. Not content with that, you have established records in the manufacture of munitions themselves. More than $282,000,000 worth of hand arms has come from your factories. About $391,000,000 worth of ammunition has been produced in this vicinity. Your production of artillery is worth more than $63,000,000, and the parts for and complete units of combat vehicles and trucks—amounting to $255,000,000—have gone to keep our armies on the march and to carry our guns forward.

"We are all in this war! The country as a whole is doing its utmost, but no section has a record which surpasses that of the Industry-Ordnance team in the Cincinnati area. But the war is not yet won; there is no time for complacency. We must not—we cannot—rest on our oars. In truth, and with all the sincerity I can command, I tell you we have just begun to fight! We are now faced with some of our most difficult production problems—and production problems are our *real* problems!

"Your work will be cut out for you to meet the demands for heavy field artillery—the weapons themselves, the ammunition for them, and the tractors and trucks required to haul them. Our big guns have proved themselves on the battlefield. They have proved more necessary than ever as a factor in the combat team required when our armies move forward. They are being used more and more on every front. They are shooting up ammunition at a rate we never dreamed about; when they do this, it is natural that they wear out the cannon barrels. We are now faced with requirements for millions of rounds of ammunition and hundreds of spare barrels for our heavy artillery. The manufacture of these represents a real production problem."

Boston Post

THE Boston Post of the Association held a joint meeting with the American Society for Metals at the Statler Hotel, Boston, on May 5th. Both societies also collaborated in the New England War Production Luncheon sponsored by the War Production Board, the Army and the Navy Supply Services, the New England Council, and the Boston Chamber of Commerce.

OFFICERS AND OTHER EXECUTIVES OF THE NEWLY FORMED PUGET SOUND POST

Seated, left to right: C. W. Wise, president, Seattle Chamber of Commerce; Watt Fallis, Post president; C. W. Huffine, secretary-treasurer. *Standing, left to right:* Ben Ludlow, Maj. W. C. Best, R. H. Cutting, Col. M. D. Mills, Maj. D. B. Braislin, E. R. Fetterolf, Herman Herr.

At the afternoon session, Lieut. Col. John C. Solberg, chief of the Boston Ordnance District's inspection division spoke on "New Trends in Ordnance Inspection." Lieut. Col. G. B. Jarrett, chief of the Foreign Matériel Branch, Aberdeen Proving Ground, also spoke on "Enemy Equipment." Among the speakers at the dinner which concluded the meeting were C. P. Dennett, president of the Boston Post of the Army Ordnance Association, and Brig. Gen. E. E. MacMorland, deputy chief for planning, Ordnance Field Service Division. General MacMorland spoke in part as follows:

"It has been neither the quality of Ordnance firepower nor the ability of our troops to use highly technical Ordnance equipment that has created problems in this war. Supply has been a problem—not a problem of quantities of supplies but the problem of distances over which tremendous quantities have had to be moved. It has been the problem of initial filling of long pipe lines. There has never been an inadequacy at the pump, and once the flow reached the faucet there has never been an inadequacy at the outlet.

"The length of our supply lines is tremendous because we have carried the fight to the enemy. Wherever we fight, the distance from the United States is great. Distances for redistribution of supplies within some theaters of operation are also great. For example, in the Southwest Pacific, after supplies reach Australia, it is as far to Finschafen in New Guinea as New York is from London. The lines will get longer the nearer we get to Tokyo.

"No single discussion could possibly encompass the extent of the Ordnance supply. Currently it is greater in dollar value, in weight of tonnage, and in the number of items to be supplied than any other supply problem of the Army. There are 330,000 different items of Ordnance spare parts in addition to innumerable major items. Here are only a few of the major items which were delivered in 1943, all through Ordnance Field Service: 9,500 light and medium tanks, 20,000 75-mm. tank guns, 91,000 bazookas, 648,000 submachine guns, 784,000 caliber .30 and .50 machine guns, 15,000,000 hand grenades (one type only), 16,000,000 75-mm. shells, 21,000,000 rifle grenades, 170,000,000 rounds of antiaircraft ammunition (one type only), 13,500,000,000 rounds of caliber .30 and .50 ammunition.

"Our major problems are not with shooting ordnance. They are mainly with the motor-vehicle part of Ordnance. Soldiers handle their weapons with a great deal more care than they do their means of transport. To a considerable degree this is perhaps due to a realization that a weapon, no matter what its size, is both the soldier's means of offense and defense; his life depends upon it. Undoubtedly, too, there is a considerably greater appreciation by commands of necessity for preventive maintenance of weapons.

"It would be extremely neglectful if, in discussing the twin relationship between maintenance and supply, reference was not made to the changing supply situations that are caused by the fluidity of war. Advance arrangements for supply can at the best be but educated guesses of what the demands for maintenance actually will disclose. They can be based only upon anticipation that usage will reveal something approximating what the planner estimated. It does not work that way; no one ever expected it to work that way. But there had to be a starting point, and it is amazing how accurate the starting point turned out to be in the light of subsequent performance.

"Because it was impossible in estimating needs to be accurate to the degree of perfection, supply demands are now adjusted upon a quarterly basis determined by the tactical situations as they develop or appear likely to develop. As long as the war lasts, this will be necessary. War demands fluidity, for in war nothing is certain. This thought should be carried away by every one who even in the slightest degree is concerned with the development, production, or distribution of ordnance requirements of our fighting forces. Victory will be ours more quickly if it is recognized that fluidity in development, production, and distribution is just as much required as fluidity of movement in combat."

The committee in charge of arrangements for the Army Ordnance Association consisted of Maj. J. E. Ratigan, Capt. W. J. Peterson, and F. W. Knauth. An exhibit of ordnance matériel was on display in the Statler during the meeting, and the latest War Department film communiqué was shown at the conclusion of the dinner.

PUGET SOUND POST

THE president of the Puget Sound Post of the Association, Watt Fallis, recently has announced the appointment of the following chairmen and vice-chairmen of Post committees: *Nominating Committee:* Robert Nelson, Standard Service Tire Company, chairman; Robert J. Acheson, Black Ball Freight Service, vice-chairman. *Constitution and By-laws Committee:* Donald E. Douglas, Pacific Car & Foundry Company, chairman; Col. M. D. Mills, Mt. Rainier Ordnance Depot, vice-chairman. *Membership Committee:* George A. Reid, Northwest Metal Products Com-

pany, chairman; Ben Ludlow, Seattle Chamber of Commerce, vice-chairman. *Program Committee:* Abe Parker, Northwest Metal Products Company, chairman; Maj. W. A. Gish, Seattle Regional Ordnance Office, vice-chairman. *Public Relations and Publicity Committee:* Howard M. Angell, Acme Steel Company, chairman; John E. Nagel, Coca-Cola Bottling Company, vice-chairman. *Technical and Research Committee:* Alexander Finlayson, Pacific Car & Foundry Company, chairman; Robert C. Norrie, Kenworth Motor Truck Company, vice-chairman. *Project Committee:* George S. Allin, Isaacson Iron Works, chairman; Lieut. Col. Silas Williams, Seattle Port of Embarkation, vice-chairman.

WASHINGTON POST

THE final lecture in the series on "Ordnance in Combat" being sponsored by the Washington Post and given by personnel of the Ordnance School, Aberdeen Proving Ground, Md., was held on May 31st in the Departmental Auditorium, Washington, D. C. The lecturer, Capt. Halstead James, senior instructor of the artillery section at the Ordnance School, spoke on "Heavy Artillery." The talk was followed by a panel discussion and the Washington première of the new War Department Ordnance film, "How Good Is Your Gun?" It is expected that the lecture series will be resumed in the fall.

NEBRASKA POST

PRELIMINARY steps looking toward the formation of a Nebraska Post of the Army Ordnance Association were taken recently by a group of members of the present Rocky Mountain Post. Led by a contingent of officers of the Rocky Mountain Post from Denver, a meeting was held on March 15, 1944, at the Paxton Hotel, Omaha, at which some sixty invited guests were present. Capt. Fred G. Arkoosh, Ord. Dept., presided.

Seated at the speakers' table were Maj. Gen. C. H. Danielson, Brig. Gen. P. X. English, Col. A. W. Ford, Col. M. H. Davis, Lieut. Col. S. Wiard, Capt. James Colasanti, Charles D. Ammon, Karl E. Vogel, Newell H. Orr, and Charles Saunders. Included among the guests were Army officials and prominent engineers and manufacturers now engaged in war production in the Omaha area.

General Danielson spoke enthusiastically and expressed pleasure at the idea of forming a Nebraska Post of the Army Ordnance Association. Other speakers told of the aims and purposes of the Association and all spoke of the great part the society would play in educating engineers and manufacturers and in keeping them informed of the new developments and trends of ordnance.

The national Association has acted favorably on the Post's petition for a charter and the document was issued, making the unit an official chapter of the society, as of June 22, 1944. Officers and directors will be announced in the near future.

SAN FRANCISCO POST

AFTER several years of inactivity, the San Francisco Post of the Association has been reorganized, a new constitution and new by-laws adopted, and new officers and directors elected.

As the result of a letter-ballot election which closed on April 10th, the following officers and directors were chosen: President, R. C. Force, director and former president of Caterpillar Tractor Company; vice-presidents, Charles Moore, president of Joshua Hendy Company and Moore Machinery Company, and Charles Kendrick, president of Schlage Lock Company.

Directors chosen for a 1-year term, expiring November 1, 1945, were: Samuel Kahn, president, Market Street Railway Company; Ernest Ingold, former president, San Francisco Chamber of Commerce; Roland Oliver, president, California Cap Company; and George Pollock, contractor.

The following were named directors for a 2-year term, expiring November 1, 1946: William Cavalier, retired; Ralph Elsman, president, California Water Service Company and San José Water Service Company; Carl Wente, senior vice-president, Bank of America; and C. S. Wheeler, Jr., member, Price Adjustment Board, San Francisco Ordnance District.

Messrs. Force, Moore, and Kendrick were elected directors for a 3-year term, expiring November 1, 1947. Col. Dean Witter, deputy chief, San Francisco Ordnance District, was elected to the Association's national board of directors.

A membership drive is now in progress, and Post activities are expected to get under way in the near future.

NEW YORK POST

AS the result of a recent letter-ballot election held by the New York Post the following executives were chosen to serve for a 2-year term: President, R. E. Gillmor; 1st vice-president, H. M. Tillinghast; 2nd vice-president, J. E. McNary; 3rd vice-president, T. E. Murray; 4th vice-president, J. T. Mackey; executive committee, T. F. Brown, W. A. Davidson, W. C. Dickerman, C. J. Hardy, C. W. Keuffel, A. E. Van Cleve; treasurer, C. Stewart Comeaux; secretary, Chester Mueller, Room 1900, 80 Broadway, New York, N. Y.

REPRINTS AND INDICES NOW AVAILABLE

REPRINTS of the series of articles on "The Machine Gun—The Period of Recognition" by Lieut. Col. Calvin Goddard which appeared in ARMY ORDNANCE from the March-April 1943 through the January-February 1944 issues, are now available to members without charge. A limited number of Colonel Goddard's second series "The Machine Gun—A Period of Evolution," are also available. The first series of articles, "The Machine Gun—Its Early Applications," is now out of print.

Also ready for distribution are copies of the ARMY ORDNANCE Index to Volume XXVI which covers subjects and authors in the January-February, March-April, and May-June 1944 issues. The index is printed with title page for binding with volume XXVI and is arranged alphabetically and cross-indexed for easy reference. Readers who wish to have past volumes of ARMY ORDNANCE bound may also obtain indices for them. Address all requests to the Executive Offices, 705 Mills Building, Washington 6, D. C.

NECROLOGY

NOTICE has been received of the deaths of the following members of the Association: R. P. Bagley, Camden, N. J.; Murray Beebe, Mt. Carmel, Conn.; George Birkenstein, Chicago, Ill.; Norman E. Botwinik, New Haven, Conn.; Bruno W. Brooks, Arlington, Va.; Harold Caminez, Williamsport, Pa.; Robert W. Canfield, Fort Myers, Fla.; Charles Copeland, Wilmington, Del.; Joseph R. D'Aloia, Hollywood, Calif.; Merrill N. Davis, Bradford, Pa.; R. E. Demmon, New York, N. Y.; G. L. Dumbauld, Pittsburgh, Pa.; Thomas N. Dysart, St. Louis, Mo.; James L. Goodwin, Hartford, Conn.; Frederick W. Hallam, Richmond Hill, N. Y.; F. Hazen, Hackensack, N. J.; R. L. Hinckley, Burbank, Calif.; H. S. Hitchcock, Los Angeles, Calif.; J. P. Jefferis, Worcester, Pa.; Francis K. Kernan, Utica, N. Y.; Earl D. Knisley, Kenmore, N. Y.; T. E. Madsen, Bethesda, Md.; Charles E. Malley, Springfield, Ohio; Robert F. Morrison, Scarsdale, N. Y.; Harry T. Peters, Washington, D. C.; Howard Reed, Philadelphia, Pa.; F. S. Reitzel, Philadelphia, Pa.; C. B. Robbins, Chicago, Ill.; Mason P. Rumney, Detroit, Mich.; A. Guy Shelley, Washington, D. C.; A. J. Sterling, New York, N. Y.; Curtis H. Veeder, Hartford, Conn.; H. W. Young, York, Pa.; Michel C. Zederbaum, New York, N. Y.; James J. Zimmerman, Follansbee, W. Va.; F. Zimmermann, Newark, N. J.

To their relatives and friends, ARMY ORDNANCE, on behalf of the Association membership, extends condolences.

From the Record

HIGH PRESSURE NAVAL MACHINERY

"AS a result of the American Navy's experiments and research, we have developed in our warships the ability to go farther and hit harder, with less fuel and lighter, more efficient machinery, than the ships of any other nation in the world by at least twenty-five per cent.

"The machinery in our new ships, and in most of our older, reconverted warships, is known by the awkward name of "high-pressure high-temperature steam equipment." Actually this was no new thing in steam plants ashore, but naval engineers the world over thought that such a development was impossible on ships at sea. The story of how the Navy broke with tradition is a long one, filled with both drama and controversy. We had to fight long-established shipyards to do it. We had to battle with manufacturers of ship machinery. Finally, we had a good rousing fight inside our own naval family before the break could be made.

"High-pressure high-temperature steam equipment is simply a means of generating steam and superheating it in order to obtain more pounds of energy from each ton of coal or oil consumed. We first attempted this in the PORTER class of destroyers contracted for back in 1932. But the attempt was made to use higher pressures and temperatures without designing machinery adequate to employ them. Machinery we were using then chiefly was of British design, similar to that used in the British Navy. The attempt was only partially successful.

"In 1933 we started building a new fleet. At that time we decided definitely to break with tradition to get what we wanted in new ships. Previously, shipyards had been building our ships and all their parts. They were not too anxious to accept new machinery designs, for that involved retooling and completely redesigning their production facilities. But we were determined to have machinery on ships as efficient as any on land. To do this, we placed orders for new-type turbines, gears, and other complicated machinery with companies sometimes far inland, and called on them for their best workmanship. I can say today that we got it. Thereafter, shipyards became shipbuilding yards and assembly points for the machinery that went into the hulls. Only through this change in procedure were we able to build our present Navy and Merchant Marine. At the same time, we became independent of any foreign design or construction. From that time on, the power of American warships was limited only by the resources of American scientific knowledge and industrial abilities.

"Specifically, high-pressure high-temperature steam development resulted in heavier armament on our ships: weight formerly carried in machinery was lessened to make way for more protective covering. At the same time it allowed us to increase the weight and number of guns carried, so that today our battleships have one hundred times the antiaircraft firepower they had at the beginning of this fleet conversion."—*Address delivered for Rear Adm. H. G. Bowen, U.S.N., by Comdr. R. J. Walker, U.S.N. (Ret.), before the Advertising Club of New York.*

CHEMICAL WARFARE

"IF you ever do decide to use gas, we are ready, willing, and able to give you measure for measure, running over and trampled down. You Germans do not like white phosphorus. You will get white phosphorus. Whenever your troops block our advance, white phosphorus shells from our mortars will blind you with smoke and drive you from your foxholes with flaming particles. You Japanese do not like fire. You will get more fire. Our chemical grenades will be thrown into every dugout where you wait in ambush. Our flamethrowers will blast your machine-gun nests. The trail of fire will burn through each stepping-stone of the Southwest Pacific to the heart of Tokyo. . . . Chemical warfare is a front-line job. . . . When invasion is ordered, chemical troops must lay down the smoke screens without which landing attempts would be suicidal. . . . When our smoke gets in their eyes, enemy gunners, waiting in the hills and on the beaches, have to guess at their targets. . . . Smoke is only a part of the picture of CWS. Our troops are also used as artillery, carrying their wicked 4.2 mortars to places inaccessible to field guns, blasting tanks and machine-gun nests with burning phosphorus and high explosives."—*Maj. Gen. William N. Porter, Chief of the Chemical Warfare Service, on the "Army Hour" program.*

INDUSTRY AND THE INFANTRY

AS the war progresses I am greatly impressed by the marvelous job that American industry has done. Certainly its achievements have never been equaled in history. But let us make no mistake—essential as it is, production cannot *win* a war. It is true that lack of production can lose a war, but production cannot win one. I wish that it could.

The products of industry are used by fighting soldiers. The period when they are used on the battlefield is the critical, decisive, phase of war. Sometimes our soldiers smash that equipment. More times the enemy does.

I remember working my way to a vantage point on the front line—within sight of the famous monastery above Cassino. I saw what appeared to be an empty foxhole; for as I got close to it I noticed a Garand rifle, thoroughly chewed by shell fragments. The wooden stock was in slivers—the mechanism worthless. To my surprise a soldier stuck his head from the hole. I asked him if that were his rifle. "Yes, it is," he said, and reached over and placed his hand on the wreckage. "It is pretty well smashed," he said, "I should have taken better care of it. It was that shell that just lit here a minute ago. I was just able to duck, myself." Then he brightened up a bit. "But I've still got six hand grenades!"

Equipment of all kinds is used up, smashed, and worn out, from Garand rifles to the most complicated machines of war. Industry must continue to feed in its products, in great quantity, and of the highest quality.

I wish that every American would see just what our men have gone through, and are going through, in Italy. For the fighting soldier at Anzio and Cassino it means day after day of struggle: struggle against rain, sleet, and ice; struggle against fatigue—heavy, sodden, overpowering fatigue; yet his job requires him to go up another thousand feet; struggle against the stupefying blow that strikes when one of his comrades is killed.

I wish every American could have been with me when I asked one of these men, "How are you getting along?" Covered with mud, bleary-eyed from lack of rest, the infantry soldiers have looked up, squared their jaws and, without exception, have replied: "Fine, sir." They were not fine. They knew that I knew they were anything but fine. But they would not admit anything else.

We had hoped that airplanes, tanks, artillery, and machines could carry the major part of the load of battle. We had hoped that in this war infantry could be charged with a minor rôle. It does not appear to be so. The infantry soldier still carries almost the entire load. On those fronts such as in Italy . . . this is most apparent. There, for each individual private soldier of the Artillery, Air Corps, Engineers, or other arms that is killed, there are 30, 50, even 100 privates of Infantry who make the supreme sacrifice for their country.—*Brig. Gen. W. H. Wilbur, assistant commander, 36th Infantry Division, before the American Society of Newspaper Editors, Washington, D. C.*

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THIS ALVEY-FERGUSON Trolley Conveyor with pendant-type carrier hauls filled containers from remote parts of the building—at the most practical handling speed—and with uniform safely spaced distances between containers.

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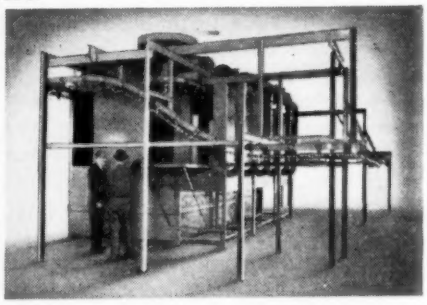

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Professional Digest

New German Equipment

NEW portable enemy pillboxes and the development of other weapons added to the difficulties of the Fifth Army ground forces in attacking the German line in Italy. The prefabricated, kettle-type pillbox is turned upside down, set on two wheels, and drawn by a tractor. It has been called one of the most astonishing defenses the Germans have developed. It is about five feet wide, and almost six feet high, but only the 6-inch concrete dome and machine-gun snout are visible—and then only within ten yards, because the installation is generally well camouflaged, and the gun fires a smokeless powder. A bellows cools the gun after it is fired. A steel lid can be drawn over the port, and, when this is done, observation is through a pair of periscopes jutting from the top. The pillbox is manned by a crew of two.

The Germans also are now using a new "wooden-shoe mine" extensively in Italy. It has been called "the worst curse of them all," for it is designed to defy our mine detectors, which register metal under the ground, by the use of plywood or plastic cases enclosing two tiny tacks, a spring, and firing pin. It looks like an innocent bar of soap but it has enough TNT in it to blow off a man's foot when stepped on.

To shield his artillery, the enemy constructs shrapnelproof covers of concrete and steel. German soldiers consider themselves so well protected in this manner that they build permanent bunks under them to use while awaiting our attacks.

As an example of resourceful use of Italian terrain in their stubborn defense, the Germans installed a 170-mm. gun in a tunnel near Presenzano, moving it out on steel rails for firing and returning it to cover after a barrage had been laid down. However, after two nights of shelling American forces, the gun was detected by an artillery observation plane which directed concentrated fire against it, putting it out of action.

The Germans are masters at digging in. They burrow tunnels and make shelters of ravines, and they never do the same thing twice.

Among newer weapons developed by the enemy is one similar to the American bazooka, called the "Faustpatrone" and "Revenge Weapon." However, a German prisoner has reported that no German soldiers would use it willingly after one had exploded on being fired, shattering the user's head and ripping his body.

German prisoners invariably said they had never encountered artillery fire which matched that of the Fifth Army. Some who had served in Russia described our artillery as far more destructive than any encountered there.

The German's 60-ton Tiger tank is powered by a liquid-cooled V-type motor of 650 to 700 horsepower, giving the vehicle a speed of as much as 28 miles an hour and the ability to climb slopes up to 40 degrees. From the motor in the rear, the power is transmitted by a universally jointed shaft to an 8-speed transmission located in the front of the tank between the driver and the radio operator, and from this to the shafts of the spurred wheels which drive the chains. In place of the usual "stick" steering arrangement and the normal gearshift, the Tiger has a steering system operated by a wheel like that of the ordinary motor vehicle. The tank turns by the separate braking and accelerating of the treads, the power being applied by an oil hydraulic system. Thus the handwheel serves only for control or release of this power. Similarly, in the case of the transmission, there is provided only a small preselector, after a system already familiar in automobiles, while the actual process of shifting gears follows this automatically without requiring any effort on the part of the driver.

The apparent German obsession with remote-controlled

weapons—now extending, it is disclosed, to "beetle" tanks, containing a charge of about half a ton of explosive—is a curious development in the methods of an enemy whose forces have not shown, hitherto, any marked reluctance to engage in combat at close quarters, even against considerable odds. No positive evidence has been adduced regarding the rumored radio-controlled giant rocket with which the Germans are alleged to have been experimenting, but the rocket bomb, similarly controlled, has been used against allied shipping in convoy.

The "beetle," it is stated, has been used in Russia as well as more recently in Italy. According to one account, it is radio-controlled; according to another, it is electrically operated, through wires which are unreeled as the tank advances, from a control position in the enemy's forward lines, after the manner adopted in the Sims-Edison electrically propelled torpedo developed in the United States many years ago. In profile, the "beetle" resembles the British Mark VIII tank of World War I, the idle half of the track, between the rear and front sprockets, passing over the top of the body. No device of this kind, however, can be so effective as a few well-aimed rounds from a moderately heavy gun.

Paper Salvage at Ordnance Depots

HUNDREDS of different ways have been found at Ordnance Field Service depots and arsenals to save the taxpayers' money by developing new methods for salvage of material which in other days might have gone to waste. Not only is paper saved and sold, but by the simple process of dumping all waste paper upon a conveyor belt and having it sorted into its different grades, Army Ordnance establishments are able to obtain a higher price from paper dealers than would otherwise be possible.

In one Ordnance Field Service depot alone, the record of paper salvage in the first three months of 1944 totaled 754,780 pounds, with the month of March leading with 358,280 pounds. Totals in January were 208,880, and in February 187,620 pounds. In this depot there are thousands of technical manuals printed for Ordnance troops all over the world, giving them instructions on how to repair Ordnance fighting equipment. These manuals are prepared to fit into the well-known binder for Army regulations, and odd-shaped holes are punched into the printed manuals. Even this paper that is punched out is swept from the floors in the bindery, put into sacks, and sold back to the paper mill to reduce the cost of operating Ordnance depots.

While the fiber containers in which shells for the 75-mm. gun are shipped overseas are not exactly paper, they can be salvaged and sent back to paper mills where the fiber can be made into shipping boxes. Heretofore, these fiber cylinders contained the empty cartridge cases when they were shipped back from overseas after use. Ordnance Field Service found that the expense of separating the cartridge case from the fiber container was an expensive operation, but it had to be done to salvage the brass cartridge cases returned from overseas. It was found that if the fiber container and the empty cartridge could be returned separately from overseas it would save sixty-five per cent in man power and then the fiber containers could be disposed of at a profit. The Ordnance Department arranged to have this done, and the resultant economy has run into hundreds of thousands of man-hours saved and a tidy profit on the sale of the fiber containers.

Wood also is a critical item, and empty caliber .30 and .50 ammunition boxes are saved and remade into packing cases for the shipment of spare parts overseas.

Production of 100-Octane Gasoline

PRODUCTION of 100-octane gasoline, a superfuel which our combat planes must have to exert supremacy over the enemy, has increased by more than 400 per cent in the last year and a half but is still far below the ultimate needs of America's fight-

RESULTS OF RESEARCH IN WAR CHEMISTRY

These Practical Products Have Been Developed through Research in Colloidal Chemistry and May Be Found Applicable to Your Business.

Self-Emulsifying Safety Solvent dilutes with water to replace naphtha, gasoline, or benzine for grease-cleaning, hand-wiping operations in metals-processing plants. Contains no chlorinated compounds, has no flash or fire point and does not tend to defat the skin. (Data Sheet # 235)

Hydro-Sealed by floating water blanket, new high-performance Carbon Gum Digestive Solvent cleans carbon and paint from aircraft engine parts without harmful effect. Used hot, water seal prevents escape of solvent vapors. (Data Sheet # 236)

High-Potency Concentrate makes Self-Emulsifying Grease Solvent to remove insulating coats of grease and dirt from truck, jeep, tank, and automobile engines by emulsification and utilizing the heat of a warm engine. Cleaned engines operate more economically since original thermal efficiency is restored. (Data Sheet # 237)

Unique Oil removes salt; may be applied to metal surfaces wet with sea water. Cleans, dehydrates and leaves thin film of rust-preventive compound. Suitable as a cleaner-preservative and lubricant for small-arms bore cleaning. (Data Sheet # 238)

High-Boiling Dehydrating Oil absorbs residual water from parts, storage tanks or equipment. Recovery for repeated use made by simple heating above 212° F. (Data Sheet # 239)

Trichlorethylene Replacement . . . non-volatile cleaning and scouring solvent for large cold immersion tank . . . rinses with hot water. Long solution life. (Data Sheet # 240)

New Fuel Concentrate raises low-test gasoline to high anti-knock rating motor fuel . . . especially applicable for high-compression motorcycle engines . . . increases performance. (Data Sheet # 241)

Sparkling Clear, water-in-oil cooling compound emulsion facilitates work inspections without stopping tools in metal-cutting and grinding operations. (Data Sheet # 242)

Emulsifying Compound cleans oil from camouflage paints; restores dead, flat, lusterless surface. Shipped as a concentrate. (Data Sheet # 243)

Instrument Shampoo emulsifying solvent cleans optical lens and delicate mechanisms without harmful effect. Results in physically clean work and complete absence of any film. (Data Sheet # 244)

Fluid, Pre-Paint Cleaning extracts and emulsifies all traces of wax, oil, and grease from hard surfaces. Rinses with water . . . leaves no film. (Data Sheet # 245)

Carbon Tetrachloride Replacement . . . a methylated aromatic solvent available in open-top lever closures, 5-gallon kits including a steel dipping and drier basket. Designed for mobile unit shop, bench cleaning.

Gunk . . . this versatile base concentrate when diluted with appropriate solvents anticipates every automotive, military, and industrial grease-cleaning problem. (Data Sheet # 248) Formulae available.

Write for Catalog and Engineering Data Sheets

Gunk CLEANS CLEAN

Confidential formula bulletins will be made available whenever the particular purpose and use that the formula is to serve is described.

CHEMICALS for Cleaning and Finishing

Success or failure in metal fabrication and finishing depends on chemical cleanness. Paint and other finishes will temporarily cover an unclean surface but unless rust and rust producers, scale, grease and oil are eradicated, the finish breaks down prematurely leaving the metal unprotected.

A recognition of this fact has led to much research and development of new and better materials and methods for cleaning and protecting metal surfaces. The American Chemical Paint Company has, for over a quarter of a century, devoted its research facilities to this particular chemical field originating and developing products which have eliminated many problems of the metal-working industries.

Deoxidine— By reason of its ability to eradicate rust and produce a steel surface clean chemically as well as mechanically, Deoxidine overcame one of the more serious difficulties of the automobile industry in its early days.

Kemick— A Heat-Resisting Paint—In the pioneer automobile days, Kemick provided a means for durably coating exhaust manifolds and exhaust lines that attained temperatures too hot for ordinary paints, eliminating the costly and more fragile coatings of vitreous enamel.

Rodine— Pickle Bath Control—Rodine made possible substantial savings in pickling acid, reduced the dissolution of metal and improved pickling conditions to an extent that pickling became a scientifically controlled operation.

Deoxylyte— Early in the automobile age, Deoxylyte was developed as a means of controlling rinse baths, in the metal-cleaning process, at the proper pH so necessary to durable finish coats.

Peroline—Developed for the auto-body builder as a means of preventing rust and thus reducing the amount of Deoxidine required to clean bodies and sheet-metal parts in preparing them properly for painting. Peroline is a combined cleaning chemical and oil which removes light rust coatings, destroys rusters on the metal and preserves the clean surface.

Cuprodine— Steel surfaces are treated and coated with copper without the use of current. Cuprodine provided a new type of lubricant which was rapidly adopted by the steel industry in the drawing of wire, and by others to facilitate difficult drawing.

Other Products— The above are but a few developments of ACP research. Other products none the less important include:

Pickle Bath Toner—Improves Pickling of Oily Work.
Cuprotek—Copper Coating Protection.
Flosol—Soldering Fluxes.
Ridoline—Alkaline Cleaners.
Ridosol—Improves detergent properties of Alkali Cleaners.
Solvent No. 3—Speeds paint and enamel removal.
Lithoform—Makes paint adhere to zinc surfaces.

These are typical of the many chemical products which have been developed by the ACP Co. for use in cleaning, pickling, and the fabrication of metals.

Manufacturers of Inhibitors and Metal Working Chemicals

AMERICAN CHEMICAL PAINT CO.
AMBLER ACP PENNA.

Note — West Coast Plants may address inquiries and orders for prompt delivery to: Leon Finch, Ltd., 720 East 59th St., Los Angeles, California.

Professional Digest

ing forces, according to the Petroleum Administration for War. In a few months, production will be about eight times greater than in the spring of 1942. Even this quantity will be below minimum needs when further planned expansion of the air forces is accomplished.

Since December 7, 1941, the Petroleum Administration for War and the oil industry have initiated seventy-two major 100-octane construction projects. Of these, thirty-two have been completed. The remaining forty will be completed in 1944. To meet increasing military needs, twenty-two more plants will be built in 1944.

Altogether about $900,000,000 is being invested in production facilities for 100-octane gasoline, the program exceeding that for synthetic rubber in both size and cost. More than seventy-five per cent of the cost is being borne by the oil companies.

In addition, the technologists discovered how to get 4.2 gallons of 100-octane gasoline from every barrel of crude oil. Previously, the yield was .21 of one gallon. The result of this process is less automobile gasoline from the barrel. Due to the cracking process used to get 100-octane gasoline, less heating oil is also obtained from the barrel of crude.

As recently as 1933, 100-octane gasoline was a laboratory curiosity. At that time it would have cost sixteen dollars a gallon. The first 100-octane sale made to the Army in 1934 was at two dollars a gallon. Today, 100-octane is bought by the Government at less than fifteen cents a gallon.

The exact figures for the increased performance of military planes using 100-octane are secret, but the Navy has released the following figures for a twin-engine commercial transport plane: using 87-octane gasoline, the plane needs 2,400 feet for take-off; with 100-octane it needs only 2,000 feet—a reduction of 16 per cent. With 87-octane, it can climb 1,000 feet a minute; with 100-octane, it can climb 1,400 feet a minute—an increase of 40 per cent. With 87-octane, it can cruise at 176 miles an hour; with 100-octane, it makes 191 miles an hour. With 87-octane, its surface ceiling is restricted to 22,000 feet, but this is lifted to 28,000 feet by use of 100-octane fuel.

An All-Weather Chamber for Testing Aviation Equipment

ARMY research men at the world's largest aviation proving grounds at Wright Field, Ohio, have now become their own weathermen, manufacturing at will desert sandstorms, Arctic hurricanes, and samples of the stratosphere nine miles above the earth to test fliers and their equipment.

The artificial weather is created in a new aëromedical laboratory at Wright Field—the most complete of its kind ever built. Equipped by air-conditioning engineers of the York Corporation, the weather-making equipment includes a steel stratosphere test chamber and a refrigerating plant capable of producing nearly every type of climate in the world.

In a stainless-steel-lined room sealed from the outside air, Army experimenters can switch from an Alaskan winter at 50 degrees below zero to the climate in a tropical sea at 150 degrees above. Inside the Army Air Forces stratochamber a few feet away, the temperature is dropped and air pressure reduced to a partial vacuum to simulate an altitude of 45,000 feet.

The sensation of shooting into the stratosphere at 600 miles an hour is created in the stratochamber when atmospheric pressure is depressed from a normal of 14.7 pounds to the square inch to less than 2 pounds in 4½ minutes.

The new weather room has its own artificial "sun" made up of batteries of both ultraviolet and powerful infrared heat lamps to simulate as closely as possible the actual sunburning and heating effect of a tropical sun. A total of 15,000 watts of ultraviolet energy is produced by the sunlamps alone. Even a "tropical sea" and life rafts can be added to the scene.

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Huge fans and blowers can be utilized to whip up artificial sandstorms, tropical rainstorms, and icy gales and sleet storms at humidities ranging from abnormally dry to one hundred per cent of saturation. The room can also be filled with a thick blanket of fog. Effects of this manufactured weather are observed through observation windows six inches thick and built of five thicknesses of glass to prevent vaporizing or frosting which would obstruct the view. Stainless-steel walls of the room protect it against leaking and corrosion.

Every bit of gear which a pilot carries is subject to tests in the all-weather room, according to Wright Field engineers. Included are life rafts, guns, emergency food rations, and all articles of clothing—especially vital items such as raincoats, gloves, and sleeping bags (see illustration). In the case of emergency rations, metabolism tests are made in the chamber on Air Forces subjects after they have eaten the food.

REPAIRING A MACHINE GUN AT 40 BELOW ZERO

The new aëromedical laboratory was devised to give the Army Air Corps every type of ground or aërial climate which fliers will actually encounter in battle. Results of these various weather tests may bring about changes and improvements in fliers' equipment and in the equipment of their planes, according to Army engineers. Some of the extreme cold tests in the weather room and in the stratochamber require as long as twenty-four hours to set up.

CARE OF SYNTHETIC RUBBER TIRES, TUBES, AND TRACKS

NEW and crtically important installation procedures characterize the new bulletin now being published by the Office of the Chief of Ordnance, Detroit, to inform the Army on its new synthetic rubber tires, tubes, and tracks. Publication of the bulletin was initiated by the Maintenance Division of Army Service Forces. The relatively brief technical bulletin, TB 31-200-1, disseminates immediate information to the field. The Office of the Chief of Ordnance will later publish a revision of the technical manual on tires, TM 31-200, embodying the extensive data accumulated thus far on the new "Government rubber."

Practically all new tires, tubes, and tracks now going into

Farquhar

FOR POSTWAR PLANNING

Farquhar Hydraulic Presses today are affecting the shape of things to come with pressures of 3 to 7,200 tons. Take powder metallurgy, for example: this is not a new art, yet hydraulic pressure applied to mixed metal powders is turning out and will continue to develop unheard-of metal applications.

In metal working, ceramics, dehydration, food processing, lamination and a host of other industries, engineers are turning to Farquhar for self-contained production presses . . . to speed new processes . . . to replace slow and obsolete equipment. They rely on Farquhar to *get things done* with speed, smooth power, and precision control.

Years of building hydraulic presses of many types give Farquhar a head start on new process needs. That's why so many production engineers are making Farquhar their replacement center on the hydraulic front.

Farquhar

ARMY E NAVY

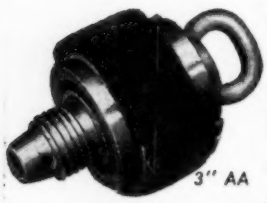
- Hydraulic Presses
- Material Handling Conveyors
- Special Machinery

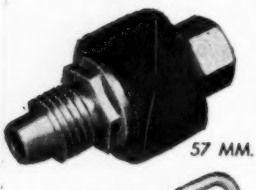
A. B. FARQUHAR COMPANY
1507 Duke St. York, Pa.

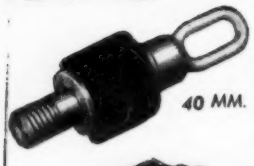
Fullergript Bore Cleaning Brushes

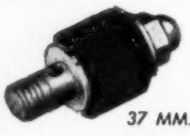
Made to Ordnance Specifications from 37 mm. up to and including 240 mm:

155 MM.


3" AA


57 MM.


40 MM.


37 MM.

Above is shown the popular 155 mm. brush such as is used for the famous Long Tom Gun. Other size brushes are used for anti-aircraft batteries, tanks, and pack howitzers. Brushes are also provided for cleaning breech mechanisms and elevating gears.

Fullergript Brushes are made to Naval Gun Factory specifications from the one-pounder size up to the six inch gun.

We act as prime contractor or can sub-contract brushes or parts to manufacturers of carriages and accessories.

THE FULLER BRUSH COMPANY
Industrial Division Dept. 8C
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service are manufactured wholly or in part of synthetic rubber. The bulletin stresses the fact that they have special characteristics because of their synthetic nature, and consequently several standard procedures of installation have been revised, particularly with respect to synthetic tubes.

The bulletin calls particular attention to the extra care that must be given to maintaining correct tire pressures. Underinflation is more harmful to synthetic rubber than it is to natural rubber. The flexing action in the side walls that results from underinflation sets up a relatively higher temperature in the synthetic product, and the higher temperature causes damage. A synthetic tire, however, if kept properly inflated, will flex normally. It is equally important that overinflation be avoided, too, since excessive pressures make the tire more susceptible to bruises and hasten wear.

The bulletin is based on a statement which has the concurrence of S. P. Thacher, chief of the Rubber Branch, Production Division, Army Service Forces, and covers "Installation" in these paragraphs:

"The procedure for installing synthetic tires is somewhat different from the procedure for installing natural-rubber tires. The installation of synthetic tubes, especially, involves a critical change in procedure. Rims must be thoroughly cleaned before installation. All grease and grit, scale and rust must be removed. Scale and rust, especially, can seriously damage a synthetic-rubber tube. Inspect casing inside and outside carefully for nails, glass, cuts, breaks, and rough spots. Even small breaks, cuts, or rough spots will chafe a synthetic tube. Clean the inside of the casing thoroughly before installation.

"Dual tires especially, and all 'driven' tires on a vehicle must be matched as closely as possible for size. They must never, under any circumstances, vary more than three-quarters of an inch in circumference or one-quarter of an inch in diameter. Directional tires must be mounted so that the tread designs are in the proper direction.

"When inflating tube before inserting it in the casing, do not inflate beyond a point where it rounds out. Synthetic tubes are not as elastic as natural rubber tubes and will be weakened, or even rupture, if care is not exercised. Synthetic tubes do not slip into position as readily as natural rubber tubes. For this reason it is imperative that the tube be completely dusted with talc or soapstone before installation. When inserting a synthetic tube, care should be exercised to have the tube as evenly and correctly placed inside the casing as possible.

"When flaps are used, they must be dusted with talc or soapstone, and they must be installed carefully so that they are well centered and free from wrinkles. When tires are mounted on a drop-center rim, be sure the tire beads are out of the rim well before inflating. If they aren't, the tube may pinch and tear. Inflate tube partially to pull tube and casing into approximate position. Then inflate to proper pressure. This new 2-step inflation procedure is of vital importance."

The new synthetic products are easily identified. The casings bear a circular red spot on which appear the letter "S" and a number. Inner tubes carry a red or blue stripe completely around their base. A red spot identifies synthetic-rubber tracks.

Bridge-Erecting Trucks Speed River Crossings

ENEMY troops who believe they can still cut off pursuit by blowing up bridges are in for a big surprise. Using newly acquired bridge-erecting trucks, Army combat engineers can build ponton bridges capable of carrying our heaviest mechanized equipment—and do it in a few hours. In recent maneuvers, the 22nd Armored Engineer Battalion built a 330-foot bridge of rubber and steel in three hours and two minutes.

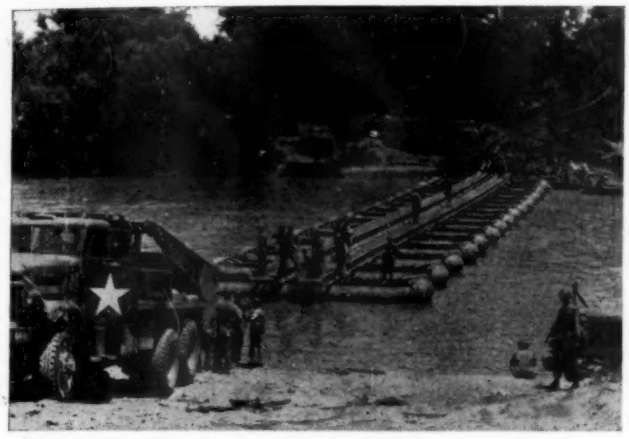
This amazing achievement is accomplished with the help of

Professional Digest

an entirely new type of equipment carrier and erecting unit, bringing into use longer, sturdier pontons, improved steel saddles, and wider treadways. The special steel carrier body and its 8,000-pound-capacity crane are especially built by the Heil Company, Milwaukee, Wis., for mounting on a Brockway Army truck. Each big truck carries pontons, steel saddles, and four 2,000-pound treadways for thirty feet of bridge. They are thirty-one feet long, nine feet high, and weigh twenty-six tons loaded, but they are fast and easy to handle.

The crane is fourteen feet long, hinged at its base and hydraulically controlled. Swinging from its traveling position along the outsides of the body, it picks up the heavy steel treadways, two at a time, unloads and positions them for securing to the pontons, as shown in the illustration below.

Another feature of this big carrier is the 25,000-pound, double-drum winch mounted just behind the front bumper. While winches are standard equipment on most large mobile Army units for pulling themselves or other equipment out of difficult spots, this one serves another important purpose. Sometimes it is necessary to position treadways from a high bank or cliff to a point lower than that attainable with the regular crane chains.



THE NEW CRANE-EQUIPPED BRIDGE-ERECTING VEHICLE

The cable from the Heil winch is then treaded through a fair-lead at the rear of the truck and through a snatch block fastened at the end of the crane's load chains so that equipment may be lowered far beyond the normal range of the boom.

When a fleet of bridge trucks arrives at a bridge site from a camouflaged dispersal point, things happen quickly and with split-second precision. The first truck backs into position at water's edge, a big Seiberling ponton comes out of its heavy canvas covering and is unrolled to its full 33-foot length. Valves are opened and a mobile air compressor fills the bag. It takes a lot of wind to inflate the big, oblong doughnut, but these truck-mounted compressors have the ponton ready to take to the water in five minutes. Bulkheaded air compartments keep these pontons afloat even under strafing attacks.

When the ponton is floated, the carrier moves close to the water's edge, and the hydraulic crane unloads steel saddles which fit snugly over the ponton, giving it rigidity and protecting it from bullets or flying shrapnel. The saddle is secured by straps at 4-foot intervals. Now the crane unloads the perforated steel treadways which are fifteen feet long and have high guard rails along the outside of their 2-foot width. Two pontons supporting a pair of treadways make a 15-foot bridge section. Completed ponton bridge sections are then aligned and overlapping treadways are bolted together.

When three sections—forty-five feet of bridge—have been joined, they are ferried across the stream with an assault boat and fastened on the opposite shore. An amphibious jeep and a

Boilermaker's pride!

Photo by U. S. Army Signal Corps

TANK SMASHER BY FITZGIBBONS

is an alternative title for this picture. It shows one of Uncle Sam's M-7 Tank Destroyers, whose 105 mm. gun is calculated to turn the toughest enemy tank into scrap in a few seconds. The chassis and assembly work in large numbers of these units is a Fitzgibbons job. We're a bit proud of it.

After all, it is something of an honor to be handed a job like the building of these Tank Destroyers. Fitzgibbons was selected because of the excellent record of our men and our shops in the production of General Sherman tanks. We feel as though we had a medal pinned on us. And we're more than determined to keep on earning the distinction.

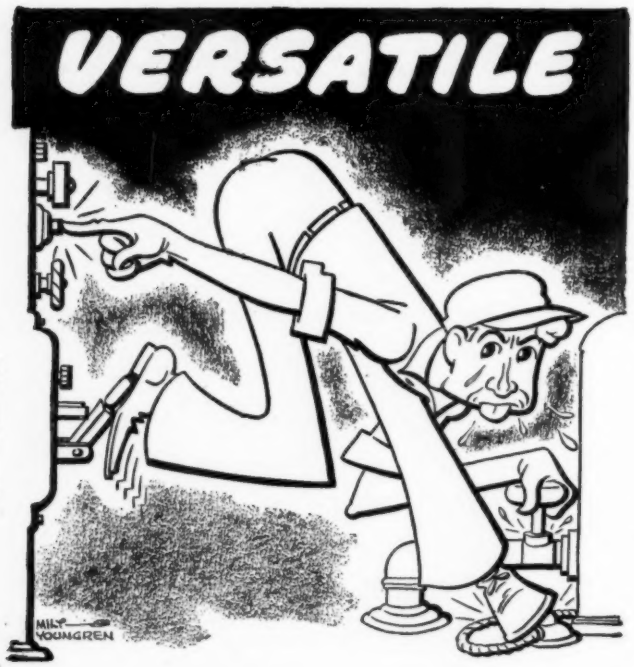
BUY U. S. WAR BONDS and STAMPS

It's not such a jump from welded steel boilers to welded steel armored fighting equipment. Nor will it be such a big jump back again to steel boilers. And those Fitzgibbons boilers will be even better in engineering and workmanship, because of the broadening experience of Fitzgibbons wartime production.

A STAR HAS BEEN ADDED to Fitzgibbons' Army - Navy "E" flag, evidence of continued excellence in wartime production.

FITZGIBBONS BOILER COMPANY, INC.
101 PARK AVENUE, NEW YORK 17, N. Y.
Works: Oswego, N. Y. • *Branches in Principal Cities*

FITZGIBBONS
STEEL HEATING BOILERS SINCE 1886

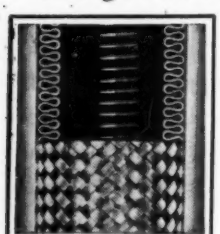


REX-WELD combines 8 other advantages with MAXIMUM FLEXIBILITY

REX-WELD is preferred by many designers and manufacturers. Because of its satisfactory performance under difficult conditions for long periods of time, maintenance requirements are reduced to a minimum.

In addition to providing maximum flexibility, REX-WELD is highly resistant to fatigue, handles burst pressures up to 14,500 p.s.i. and temperatures to 1000° F., remains air-tight longer, is leakproof even after hard usage, can be used for liquids that are searching and will withstand prolonged flexing.

Chicago Metal Hose Corporation manufactures a type of flexible tubing to meet every requirement. Our engineers will be glad to recommend the type best suited to meet your particular requirements. Write for catalog and complete information.



REX-WELD CORRUGATED FLEXIBLE METAL HOSE

Flexible Metal Hose for Every Industrial Use

CMH CHICAGO METAL HOSE CORPORATION MAYWOOD, ILLINOIS

Plants: Maywood and Elgin, Ill.

Professional Digest

bulldozer usually go along on the first trip so they can clear an old road or begin work on a new one. Working back from the opposite shore, Engineers keep on assembling ponton sections and ferrying them across to join the original section. This leaves the near bank clear for the assembly of new sections as successive carriers pull into position and set up the bridge units.

Finishing touches include setting out heavy anchors about fifty yards upstream to brace the bridge against the river current. About a dozen anchors do the job, and the bridge is ready for business. Heavy tanks, half-tracks, jeeps, and cargo carriers rumble safely across. Upstream, assault boats look for floating mines, while fighter planes overhead protect the convoy and the span.

Barrage Balloon Proves Effective Invasion Screen

BARRAGE-BALLOON operations have played an effective part in invasion tactics and have helped screen all ports occupied by American troops in Italy. In a report to Maj. Gen. Joseph A. Green, Commanding General of the Antiaircraft Command, Lieut. Gen. Mark W. Clark, Commanding General of the Fifth Army, said: "Very-low-altitude balloons were used over both British and United States beaches in Fifth Army landings and have been used over all ports subsequently occupied. They have also been used in protecting critical defiles."

Very-low-altitude balloons are about thirty-five feet long and look like fat fish with large tails. They are easily handled. In one instance, an officer and six men won Silver Star medals for running up and down an Italian beach with a balloon after several others had been destroyed when left stationary. The balloons support metal cables which deny important airspace to hostile planes. When a number of balloons are "sited" according to a plan and are operating to defend a particular area, the barrier presented by the cables is called a balloon barrage. The barrier's mission is similar to that of antiaircraft artillery—to provide local day and night protection for ground establishments and ground troops against aërial attack.

One report from Italy states that from the start of one operation "antiaircraft artillery, including very-low-altitude barrage balloons, caused enemy aircraft to take evasive action or fly immediately outside or above effective automatic-weapons range, thus neutralizing enemy air missions within the defended area." This report points up another purpose of the barrage. Planes flying low are often damaged or harassed by automatic weapons of the caliber .50 machine-gun and "pom-pom" types, but they are too close for effective use of larger antiaircraft weapons like the 3-inch and 90-mm. guns. By forcing the planes to fly higher, the balloons permit these larger caliber guns to be brought into play. At these higher altitudes, friendly pursuit aviation also may be sent against the attackers.

The value of the barrage was mentioned in a report to the Fifth Army commander by the commanding general of an antiaircraft artillery brigade of the army: "I believe that the presence of balloons on the beach on D-day and the following days was a most important factor in preventing hostile aircraft from flying low over the beaches. I also believe that barrage balloons are a vital element of the defense of a vulnerable area, such as a port or landing beach."

Camera Gun Tests Tank Stability

ENGINEERS who built the device for holding a tank gun steady while speeding over rough ground needed an accurate means for checking performance of the gyroscopic control. Actual firing is expensive and is not an accurate test of the stabilizer because it includes errors of the gunner's judgment in allowing for windage, range, projectile characteristics, etc., over which the stabilizer has no control. As a result, Westing-

Professional Digest

house and Army Ordnance engineers designed a novel photographic device to do the job.

A camera, built for taking pictures rapidly on standard miniature film, is clamped to the gun barrel, as shown in the illustration. The exposures are made through a telescopic lens with crosshairs. As the tank bounces over the rough test course, the gunner "fires" in the regular manner. However, pressing the trigger "shoots" a picture of the distant target instead of firing a projectile at it. The film shows how well the crosshairs follow the target—thus recording the combined performance of stabilizer and gunner.

Comparative performance of stabilized and unstabilized guns can be measured by applying a camera to the gun barrels of two tanks, one stabilized, the other not. Next, the two steel monsters

MOUNTING THE CAMERA ON THE TANK GUN BARREL

stage a "fight" under warlike conditions. The photographic record of "hits" and "misses" is then compared to determine the merit of the stabilized control.

Another photographic scheme carries the test one step further. A movie camera is similarly mounted on the gun barrel. By an arrangement of mirrors and a V slot, it takes a continuous motion picture of the target as "seen" by the gun barrel and by the tank frame. This double record shows the performance of the gun. In addition, the amount of scenery change indicates roughness of ground traversed.

NEW STEEL AMMUNITION CONTAINER ADOPTED

THE Army has adopted a new steel ammunition container designed to afford packaged artillery rounds and powder charges increased protection from handling damages. It is estimated that the Ordnance Department will require 125,000 tons of steel during the first three months of the container production program. A previous container, made of fiber and metal, provided inadequate protection: A blow on the package could dent the cartridge case, and, if the package was dropped, the weight of the projectile often caused the case to bulge, or loosened the crimp.

Although the new container has not been standardized by the Ordnance Department, orders already have been placed for its production. Hot- and cold-rolled sheet and strip steel are required, with more than one-third the tonnage to be purchased in the form of steel tubing.

HYDRAULIC PRESSES

Back the Attack

Watson-Stillman Press consolidating high explosives in projectiles at Mid-western ordnance plant.

Loading high explosive shells and armor-piercing bombs to help deliver the "knockout punch" to the Axis, Watson-Stillman Hydraulic Presses are at work night and day throughout ordnance plants and other busy war industries backing the attack.

Among these presses is the Watson-Stillman unit shown consolidating high explosives into projectiles at a Mid-western ordnance plant. This ammunition-making equipment takes its place beside many other Watson-Stillman Hydraulic Presses which are packing war wallops – some straightening gun barrels – some bending the keels of ships of our invasion fleet – others forming aircraft parts, re-conditioning railroad rolling stock, molding ceramics and plastic products, pressing powdered metal, extruding, forming and forging metals, and innumerable other operations. Write for General Bulletin 110-A.

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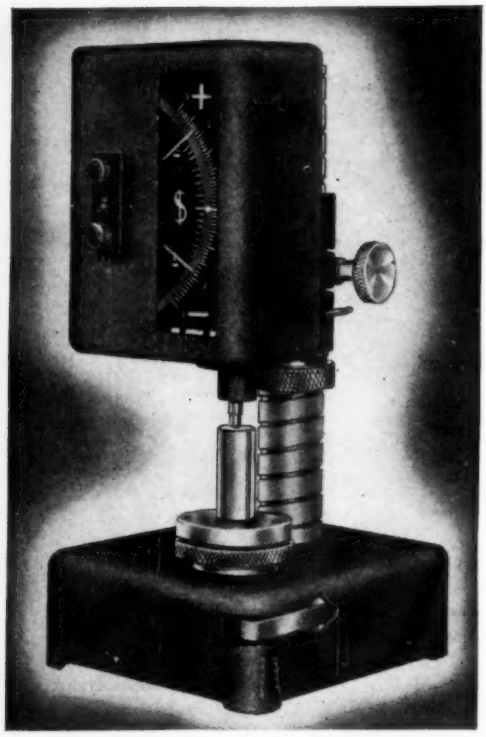

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We're well qualified to assist you in producing precision machined parts at production speed, while maintaining tolerances as fine as 1/10,000 of an inch.

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Ordnance Roll of Honor

THE officers and men of the Ordnance Department of the Army have won a proud name for themselves in this war by their devotion to duty and their knowledge and ability in the repair and maintenance of arms, ammunition, and fighting equipment of every type. Often under difficulties in this country and often under fire in the field, without sufficient sleep, food, shelter, or the proper tools, they have labored unceasingly and with success to give the fighting troops "enough and on time." In many instances their labors and personal sacrifices were over and above the call of duty, and these deeds have been officially recognized by the presentation of a War Department award. ARMY ORDNANCE *salutes the following men for their gallant achievements as well as the host of other Ordnance soldiers whose equally outstanding efforts have not been officially chronicled. Their deeds will be an inspiration to every Ordnanceman to give "more than enough" so that the day of final victory may arrive "ahead of time."*

LEGION OF MERIT

The following received the Legion of Merit for exceptionally meritorious conduct in the performance of outstanding service as outlined in the accompanying citations:

COL. CLEVELAND H. BANDHOLTZ, Oswego, N. Y.—"From June 9 to December 3, 1940, while serving as the representative of the Ordnance Department in the control and operations incident to the receipt and disposal of supplies for the allied governments as directed by the Secretary of War on June 5, 1940. Overcoming major obstacles by the exercise of tact, fine leadership, and organizing ability, Colonel Bandholtz insured the shipment of cannon, small arms, tanks, and ammunition in sufficient quantity to permit the prompt rearmament of British forces following their matériel losses on the European continent."

COL. JOSEPH M. COLBY, Lake Mills, Ind.—"He successfully organized vital training, supply, and maintenance activities during the critical period of defense in North Africa. His careful study and keen analysis of maintenance and supply methods under combat conditions resulted in the early correction of deficiencies in the system of American supply and maintenance. His observation of equipment under battle conditions contributed to the prompt correction of mechanical deficiencies and the initiation of essential developments. His complete survey of the metal-working trades and the powder and explosives industry of the Union of South Africa provided the United States troops in the Middle East Theater with a near source of many essential supplies. He achieved this success by his technical knowledge of ordnance matériel and broad experience as an engineer and by his untiring devotion to duty, which brought him the complete coöperation and confidence of all those with whom he dealt."

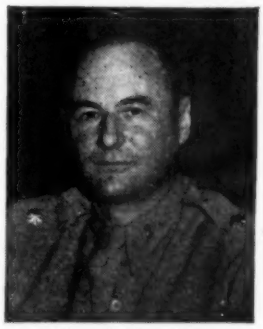
Colonel Colby

COL. WILLIAM R. GERHARDT, Martinsburg, W. Va.—"When appointed chief of the newly created Artillery Development Branch of the Technical Division, Office of the Chief of Ordnance, in July 1942, Colonel Gerhardt rapidly and efficiently organized the personnel work and procedures of this branch in such a manner as to demonstrate administrative and engineering abilities of the highest order. During the eighteen months he served as chief, the branch made an outstanding record in the number of new and improved artillery weapons standardized for the use of our troops. Colonel Gerhardt's achievements in the organization of the Artillery Development Branch and in the direction and supervision of the work of this branch in connection with the development, design, engineering, testing, and standardization of artillery matériel constitute an outstanding contribution to the war effort."

Colonel Gerhardt

LIEUT. COL. FREDERICK G. CRABB, JR., Brooklyn, N. Y.—"As division Ordnance officer from July 16, 1941, to October 24, 1943, he was directly responsible for the preparation of ordnance equipment and the furnishing of ordnance supplies to the division for the African and Sicilian invasions. The maintenance of the many different types of vehicles, including tanks and half-tracks, was a most difficult task. The perfect condition of the vehicles was evidenced by the small number of mechanical failures that occurred during combat. In Sicily his task was made more difficult by a march of approximately 160 miles in 4 days. All vehicles, including tanks and other track vehicles, were moved at high speed over poor roads and mountainous terrain. Due to his diligence and industry the necessary maintenance and ordnance supplies were furnished, enabling a high percentage of the vehicles to reach the objective. This accomplishment is particularly noteworthy because two-thirds of the maintenance personnel were left in Africa due to lack of shipping space. His efficient work contributed greatly to the capture of Palermo."

LIEUT. COL. ROBERT F. MORRISON (Posthumous). Next of kin, Mrs. Miriam E. Morrison, widow, Scarsdale, N. Y.—"As chief of the Artillery Branch of the New York Ordnance District from April 14, 1942, to the time of his death on October 16, 1943, he distinguished himself as an executive, demonstrating a masterful handling of delicate and controversial situations. The sound judgment, leadership, careful planning, intense energy, tireless activity, and devotion to duty which he exhibited in the accomplishment of his duties contributed materially to our war effort. His resourcefulness and initiative succeeded in solving many complex problems incident to the rapid expansion of district production."



Colonel Morrison

LIEUT. COL. EARL H. ZWINGLE, Washington, D. C.—"Then a major in command of a company in an Ordnance regiment and later a battalion commander, he displayed extraordinary ability, tireless energy and resourcefulness, coupled with a splendid spirit of coöperation, zeal, and efficiency while his unit was fourth-echelon supply agency during the VIII Corps maneuvers in Louisiana from July 27 to September 17, 1942. During these maneuvers, this officer's command contributed greatly to success-

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COMBAT products can again be given the special protection against fumes, moisture, extremes of temperature which are afforded by Permite Aluminum Paints. Recently issued order by the WPB relaxes restrictions on the use of aluminum pigment. On orders carrying a rating of AA-5 or higher, aluminum paints may be supplied for a broad list of permitted uses.

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On tanks on every fighting front, SKF Bearings are easing the way for rotating parts . . . bearing the brunt of heavy shock loads . . . compensating for shaft deflections, distortions or weave. Fighting *tanks* need fighting *bearings* . . . particularly where the going is tough and Performance is the thing that counts.

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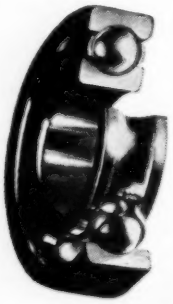

SKF
BALL & ROLLER BEARINGS

Ordnance Roll of Honor

ful motor maintenance by the rapid issue of motor parts. During the IV Corps maneuvers from September 17 to November 8, 1942, when his organization provided fourth-echelon maintenance for the IV Corps, efficient operation of this battalion, due largely to the close personal attention and supervision of Colonel Zwingle, facilitated motor transportation and materially contributed to the success of the maneuvers. In April 1943, this officer completed a study on the mortality of motor parts for general-purpose vehicles, and later, in August 1943, he provided a standing operating procedure for an Ordnance depot company, both of which have contributed greatly to the efficient operation of Ordnance depot companies."

Lieut. Col. William A. Weaver, Washington, D. C.—"As Ordnance officer of a base section in Australia from June 19, 1942, to June 19, 1943, Colonel Weaver planned and established the excellent Ordnance facilities in this base section. With a limited number of personnel available for the work, he fulfilled the Ordnance mission of his headquarters in a superior manner, setting up an Ordnance service center for the proper storage, maintenance, and issue of all Ordnance material and organizing a comprehensive system of fourth- and fifth-echelon repair shops. Colonel Weaver made a substantial contribution to the work of the Ordnance Department in the Southwest Pacific Area."

Colonel Weaver

Capt. Alfred B. Kuhn, Jr., Newton, N. C.—"In New Guinea from November 1, 1942, to January 31, 1943, while serving as commanding officer of an Ordnance detachment, Captain Kuhn was charged with designing, developing, and producing in the field some modification for increasing the fragmentation effect of standard demolition bombs. This challenging assignment was speedily met, and the resultant bomb, devised and manufactured without special tools or normal manufacturing facilities, was used with excellent effect in the Papuan Campaign and in subsequent operations. In a period of six months, several thousand of these bombs were made and expended in combat. By his inventive talent and his energy, Captain Kuhn made a most valuable contribution to the success of our operations."

Lieut. Col. August Schomburg, Denver, Colo.—"As commanding officer of an Ordnance Proving Center Winter Detachment in Canada from October 26, 1942, to March 4, 1943, by his foresight, tact, perseverance, and outstanding technical and administrative ability, augmented by dogged determination and ability to cope with severe conditions, he succeeded in completing, under severe winter conditions, precise engineering and technical tests of such magnitude that he thereby made outstanding contributions to the field of ordnance engineering. As a result of this subzero temperature research, numerous engineering and design improvements in arms, ammunition, combat and transport vehicles, fire-control instruments, armor, lubricants, and accessories are now reaching combat theaters to increase materially the battle efficiency and firepower of the using troops."

Colonel Schomburg

Ordnance Roll of Honor

MAJ. RUSSELL B. HUCKSTEP (Posthumous). Next of kin, Mrs. Russell B. Huckstep, widow, Des Moines, Iowa.—"While on duty with the Eritrea Service Command from August 31, 1942, to February 23, 1943, because of his untiring efforts, sound advice, and patience in training civilians and natives in the handling of American and allied military equipment, an arsenal and its subsidiary workshops were able to begin operating in a relatively short period of time. He was the primary organizer of an Ordnance repair shop, and through his ingenuity in utilizing scrap material for reconditioning hand weapons a critical shortage was alleviated which made possible the organizing of an American civilian volunteer guard unit. Through his long years of military experience, dogged persistence, and boundless energy he contributed in a marked degree to the successful operation of United States Army Ordnance installations in Eritrea."

Major Huckstep

CAPT. CHARLES O. MYATT, Orange, N. J.—"In New Guinea during February 1943, when the supply of bomb fuzes was interrupted and the stock of fuzes for low-altitude bombardment was depleted, Captain Myatt worked unceasingly to manufacture a satisfactory substitute which had been devised. Despite inadequate tools and supplies, he made excellent use of makeshift materials available locally. The fuzes thus produced were used in the Bismarck Sea engagement with devastating effect. Captain Myatt, by his ingenuity and energy, performed an outstanding service and made an important contribution to this signal victory."

2ND LIEUT. JAMES H. QUINN, Tuscaloosa, Ala.—"As shop foreman of the tank shop at Tripoli, Tripolitania, from March 20 to May 20, 1943, he directed the efforts of 300 men in the repair of American tanks used by the British Eighth Army in their campaign against the enemy. Many difficulties arose from the lack of spare parts, proper shop facilities, and difference in British mechanical standards. The rate of production of tanks maintained under his guidance, together with the high quality of repair work accomplished, contributed in a marked degree to the successful operation of the Libyan Service Command."

Lieutenant Quinn

2ND LIEUT. MARTIN J. A. SCHWARZSCHILD, New York, N. Y.—"As instructor from March 4 to July 4, 1942, in the meteorological section, Master Gunners' School, Antiaircraft Training Center, Camp Stewart, Ga., he devised and perfected an improved and faster method of securing ballistic data for use of antiaircraft artillery which, after thorough test, was adopted as the standard Army system. The relative simplicity, ingenuity, and accuracy of the Schwarzschild system marks a distinct advance in the method of preparing meteorological messages and results in an important saving of time, equipment, and personnel required for the determination of this essential data."

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The amazingly simplified inserted-blade step-cutter that makes high-speed carbide face-milling of steel possible in every shop!

A sensational Kennametal achievement—the KENNAMILL—can give new life to your milling machines . . . adapting them for the high speed milling of steel that is inherent in modern, negative rake carbide cutters. At the same time, the Kennamill can improve the quality of your work by producing finished surfaces that are exceptionally smooth and accurate.

Kennamills are inserted-blade cutters, available in four sizes with taper shanks to fit standard spindles, as listed below. All sizes use the same ⅝" square, 10° negative back rake Kennametal-tipped blade (Cat. No. 39M40). Two sets of blades are supplied with each cutter head.

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Kennamills are available for immediate delivery. They are stocked at our factory, and at Kennametal offices in Atlanta, Chicago, Detroit, Houston, Los Angeles, Philadelphia, New York, and San Francisco. Get in tune with the fast-moving tempo of carbide steel milling—order Kennamills today.

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(Complete, with 2 sets of No. 39M40 Kennametal-tipped blades)

Size	Fits Spindle	No. of Blades in Cutter	Price Each
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2"-50	#50	3	35.41
3"-40	#40	4	39.99
3"-50	#50	4	41.22
4"-50	#50	4	43.04
5"-50	#50	4	44.85

Extra Blades (No. 39M40) each $1.83
Templates—for regrinding blades—each $1.75

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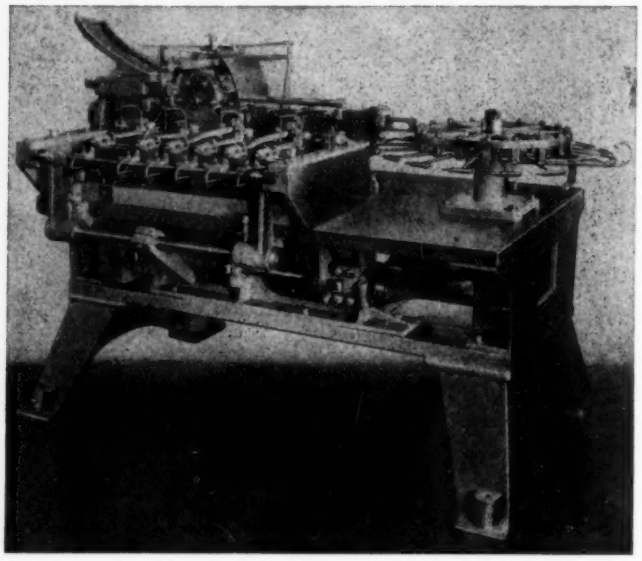

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One of our large family of Small Arms Ammunition Machinery. This line is the outgrowth of long experience in the development of machinery for the mass production of bullets, cartridge cases, etc., and the handling of explosives.

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Ordnance Roll of Honor

TECH. 3RD GRADE ROBERT V. HALL, Oswego, N. Y.—"At Tripoli, Tripolitania, from March 6 to May 21, 1943, in charge of a rejection crew at a tank shop, he was responsible for the repair of all American-built tanks. He worked in close liaison with the British technical experts and demonstrated extraordinary ability in interpreting the many and varying mechanical standards of the British Eighth Army and General Headquarters inspectors to the several crews of that shop. His devotion to duty, tactfulness, and application of marked mechanical ability were a contributing factor in the expulsion of the enemy from Tunisia."

Sergeant Hall

TECH. 3RD GRADE JOHN T. PHILLIPS, Coeur d'Alene, Idaho.—"In charge of a road recovery detail rendering aid to the British Eighth Army during its assault on the Mareth Line and living under difficult conditions as one of an isolated group of three with no shop facilities, limited tools, and only such spare parts as could be collected from abandoned vehicles, he returned to service vehicles which otherwise would have been towed to shops for repair. Approximately twelve vehicles were returned to service daily. In repairing a combat vehicle, a defect was discovered which caused the accelerators to fail to release, thus allowing the engine to continue to run at full speed. Technician Phillips designed and perfected a carburetor device which remedied this fault and proved to be of great value, thus contributing in a marked degree to the allied war effort in this theater."

Sergeant Phillips

STAFF SGT. ROBERT J. JOHNSTON, Manitowoc, Wis.—"At one time during the North African Campaign he was in charge of an emergency automotive-parts depot which he solely organized, supervised, and managed. In spite of having to labor endlessly to instruct his novice workers in theoretical knowledge and practical handling of automotive parts, he operated the depot in an effective manner. When orthodox parts were not available, he displayed unusual aptitude in offering sound suggestions of interchangeability. He has demonstrated an inspiring amalgam of loyalty to duty, progressive initiative, and superior technical knowledge which, when applied under field conditions to practical work in the automotive supply section, proved especially helpful in the North African and Sicilian Campaigns."

Sergeant Johnston

TECH. SGT. JOE BARELLO, Leachburg, Pa.—"In Australia from June 10 to September 1, 1943, Technical Sergeant Barello, in charge of a detail to inspect and repair defective bomb fuzes, trained inexperienced men for this work which required great care and exactness. By exercise of notable skill and leadership, Technical Sergeant Barello accomplished this substantial service rapidly and without accident."

Ordnance Roll of Honor

SOLDIER'S MEDAL

PFC. EMIL R. STENSTROM, Salt Lake City, Utah.—"For heroism at Morris, Algeria, on October 12, 1943. While supervising native workers unloading 75-mm. ammunition from a truck, one shell exploded, setting off several others. All but one of the natives ran to safety. One, apparently too frightened to move, remained on the truck. Private Stenstrom, at the risk of his life, climbed on the truck and succeeded in getting this man off and to safety. Immediately after this daring rescue the remaining ammunition exploded."

Private Stenstrom

(The Soldier's Medal is awarded for heroism not in actual conflict with the enemy.—ED. NOTE.)

PVT. ANDREW K. GARNER, Greenwood, S. C.—"For heroism at Aversa, Italy, on November 20, 1943. Immediately after an air attack on an ammunition dump, Private Garner, without regard to his personal safety, ran to a large stack of propelling charges which was burning and pulled the blazing part away from the other charges. Knowing that such powder is highly inflammable and that at any moment the flames would spread, Private Garner stopped the spread of fire and saved badly needed ammunition at a vital supply depot."

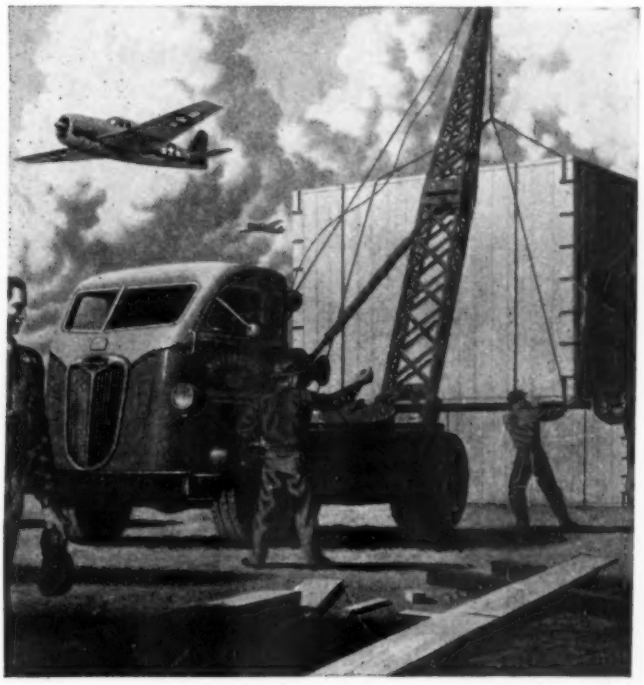
Private Garner

(Recipients of awards mentioned in the May Army Ordnance Bulletin are omitted here.—ED. NOTE.)

BRONZE STAR

1ST SGT. JAMES W. DUWALL, Belle Vernon, Pa.—"He was in charge of one section of the magazine platoon of an Ordnance ammunition company throughout the Tunisian Campaign. His section was consistently the foremost in performance and dependability in the handling of ammunition. As senior noncommissioned officer in various detachments he actively supervised the storage and issue of ammunition to the combat troops and took care of numerous administrative details as well. One detachment at Gafsa handled an average of about forty tons of ammunition per man during a 30-hour period on March 23-24, 1943, to relieve an ammunition shortage and enable combat troops to repulse a strong enemy attack. He actively and efficiently controlled the small number of men at his disposal so as to expedite operations in spite of an abnormally large amount of ammunition handled. At all times he displayed superior qualities of initiative, good judgment, leadership, and devotion to duty. He was constantly on the alert for better methods of operation, and his efforts and example contributed greatly to the supply of ammunition direct to combat troops."

Sergeant Duwall



CONTENTS...ONE HELLCAT

Heavy loads, heavy grades, and heavy going mean little to Autocar two-, four-, or six-wheel-drive trucks and tractors. This applies also to the Half-Tracks and other special-purpose vehicles that Autocar has made for the Army, the Navy, the Marines, and the Air Forces.

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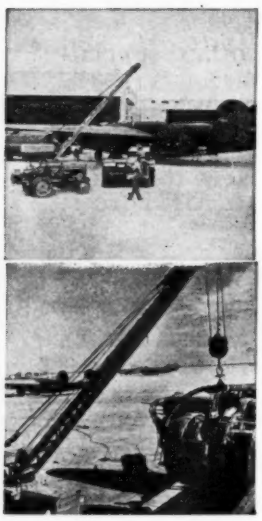

No expensive delays—Roustabout Crane picks up and moves your motor, machine, casting, crate, I-beam or whatever it is, big or small, easily, instantly. It keeps things up to 5 tons moving around your factory, railroad, dock, or airport. It's where you want it when you want it. On wheels or crawler tracks, it's easy to run, all tractor power, ball-bearing boom turntable, gears in oil, full boom swing, built for years of punishing work. Roustabout Crane is a highly profitable investment in postwar efficiency. Write now for the whole story.

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Book Reviews

JAPAN—ITS RESOURCES AND INDUSTRIES. By Clayton D. Carus and Charles L. McNichols. New York: Harper & Brothers. 252 pp. $3.50.

THE security of the Pacific depends upon the complete defeat of Japan and its subsequent occupation with allied administration during reconstruction time. The authors have emphasized that the latter must be completed before any treaty of peace is finally accepted. This book is very comprehensive, readable, and scholarly, and an essential reference book for those persons who are now or are later to be concerned with postwar problems in Japan.

The intensity of Japan's agricultural cultivation with limited variety of crops; her animal industries; mining; transportation copied after early American counterparts with little improvement; communications—with social status determined by the ownership of a telephone; cities; commercial and industrial monopolies and finance, closely held in a few ruling families; foreign trade, lost for the present because of war with her best customers, particularly for her best product—silk; hydroelectric development, so extensive that the humblest shack has its lone 10-watt bulb. These are some of the subjects covered in this book.

The format is excellent: pages are large, illustrations are clear and complete and are assembled in groups throughout the book. The entire work is summarized completely in the last chapter, using all headings and containing the meat of each account; it also has a bibliography and index.

THE WOUNDED GET BACK. By Albert Q. Maisel. New York: Harcourt, Brace & Company. 230 pp. $2.50.

THE author is an accredited Navy correspondent whose specialty is writing about medicine and doctors, although he is not a doctor himself. He describes the workings of the medical service in particular and all phases of battlefield medicine and surgery in such a manner that the reader cannot help being thankful for its thoroughness and confident of its quality.

Heroes are made every day among the "medicine men" in the battle behind the battle, but these heroes go unsung for the most part. To them it is a day-to-day job, the miraculous appearing at random along with the routine. The author has vividly described every aspect of the medicine front, and has caught the workaday humor and the high heroism of all the men who fight the Grim Reaper. This book will be of especial interest to every one who has a friend or relative in the military service.

TURKEY—KEY TO THE EAST. By Chester M. Tobin. New York: G. P. Putnam's Sons. 170 pp. $2.

CONTRARY to the usual description of "Terrible Turk," the author found the Turks to be eager, ambitious, courteous gentlemen, maligned in the interests of political, religious, and military expediency. Turkey occupies the "crossroads of the world," where the land route between Europe and Asia crosses the water route from the Black Sea to the Mediterranean. There Turkey has risen through its internal strength and the internal weakness of its opponents, only to fall and decay between times because of internal corruption and backwardness on the part of its rulers. Conflict in Turkey has been long and continuous. Greedy powers in Asia and Europe have misused the Christian and Islamic religions as tools to conquer her. The Turkish people are of good stock, but were helpless under their corrupt rulers, who in turn were ruled by Moslem law.

The Treaty of Sèvres in 1920 dismembered and distributed all of Turkey, except Anatolia. This partition played into the hands

of Kemal, the great Turkish patriot, about whom this book is largely concerned. Later as Kemal Atatürk, "Father of the Turks," he was to institute reforms in Turkey, modernize its government and customs, and demonstrate that Turkey could be a great nation, occupying a strategic place in the world.

The author feels that Turkey's future, due to her geographic location and relative military importance and the probable condition of the world after this war, is dependent upon avoidance of domination by Great Britain or Russia, while maintaining their friendship. However, after this war she must lean on Great Britain for aid and support in the event of attempts at domination by other nations. If imperialism after the war gives way to equitable, nondiscriminating coöperation, and if the United States throws in with Great Britain for the attainment of a steadily advancing world order, Turkey's future is bright. If imperialism continues rampant, however, the future is dark indeed.

This small book is an eye opener to the reader who is interested in Turkey and who is unaware of its importance. The author spent several years there, speaks the language, and has written convincingly of his knowledge of the country.

THE DYESS STORY. By Lieut. Col. William E. Dyess. New York: G. P. Putnam's Sons. 182 pp. $2.

THIS account of the defense of the Philippines, the fall of Bataan and Corregidor, and the death march of the Filipino and American prisoners was told to the collaborator, Charles Leavelle, by Colonel Dyess. It is a story that he pledged himself to tell to the American people that they might know firsthand of the barbarism and inhumanity of the Japanese. He was one of ten who escaped from a Jap prison camp in the Philippines after months of imprisonment and arrived safely under the American flag's protection again. He was later killed in a plane crash in California. Much of the story has been told in the newspapers, but the complete account is here with the continuity that the piecemeal writings lacked.

If ever there has been written an account of barbarity and man's inhumanity to man since civilization began that tops this one, it has not been published. This story was suppressed in the hope of easing the treatment accorded the remaining prisoners held by the barbarians. It has recently been released and may serve to improve things for them due to the loss of face the Japanese have suffered through its publication. This book should be read by every American and then reread.

BATAAN—THE JUDGMENT SEAT. By Lieut. Col. Allison Ind. New York: The Macmillan Company. 389 pp. $3.50.

COLONEL Ind has been an Intelligence officer with the Air Forces stationed in the Philippines and Australia continuously since 1941. He served as aide and assistant to Generals Claggett, Brereton, and George. His story is told in chronological order, in diary form for the most part, and is straightforward and fascinating. The inadequacies of our Far East preparation for war and the reasons therefor are clearly shown. The hopelessness of the defense of the Philippines, well-known months before Pearl Harbor, and the impossibility of correcting in a few months the shortcomings of years, is told with an air of resignation that should serve to tell the future legislator that this condition must never occur again.

The tragedy of Bataan, where a steadily decreasing band of patriots held on, awaiting the promised aid which could not be sent, has been told again and again, but never so clearly and in such detail.

The evacuation from Manila to Bataan, according to long-laid plans, disclosed lack of preparation on the part of the military authorities. The author pointedly notes that the Ordnance Department was the lone exception. Ordnance had prepared months previously by moving stores of munitions to Bataan, setting up depots and magazines, so that all was in readiness for the inevitable withdrawal in the war which was then but a

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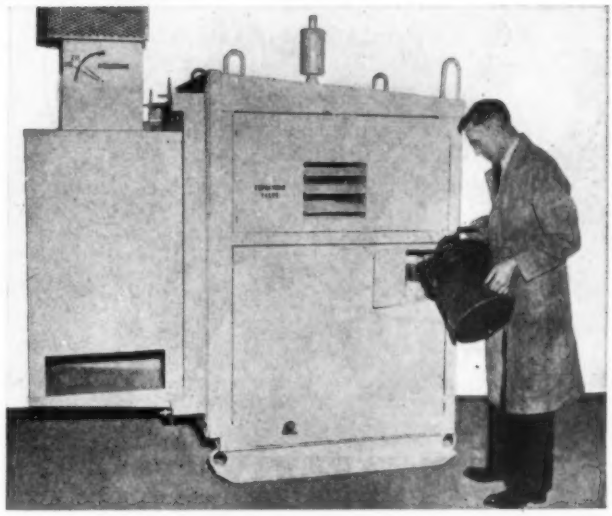

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rumor. Great credit is due some unknown and unsung Ordnance officer for exercising such initiative and foresight.

The heroism and devotion of the Americans and Filipinos alike, with so little hope of real help, is an inspiration to our Nation. The Japanese timetable of the war was badly upset by the tenaciousness of these heroes of Bataan.

This book is recommended reading for every citizen. It may even stir the indifferent and lethargic legislator in the future to positive action.

LINCOLN'S DAUGHTERS OF MERCY. By Marjorie Barstow Greenbie. New York: G. P. Putnam's Sons. 211 pp. $3.

OPENING with the gallant defense of Fort Sumter in 1861 and telling of the dramatic withdrawal of Major Anderson and his men, the author tells of the discovery of the stimulus for the entry of women into what had formerly been man's exclusive sphere—war. The fine work of Florence Nightingale in the Crimea provided the pattern; the utter lack of recognition by our Government of the need for medical attention and nursing for the wounded in the great war between the Union and the Confederacy, in which we were then engaged, provided the excuse.

From all this, many gentlewomen were spurred to organize and to obtain recognition so as later to become a part of the Army. These women of 1861 were the WACS, WAVES, and SPARS of their time and the forerunner of the American Red Cross and the Army Nurse Corps. Mary A. Livermore, of Boston; Mary J. Safford, the "Little Angel" of Cairo, Ill.; Amy Bradley; "Mother" Bickerdyke—of whom General Sherman admitted publicly, "She ranks me"; Clara Barton, who founded the American Red Cross; Mary Lee of Philadelphia, who organized the Union Refreshment Saloon and fed 4,000,000 soldiers; Kady Brownell, and many others are here depicted.

The reader is apalled at the apathy of our Government of 1861 in its approach to this need, particularly when it is considered that it all happened less than a hundred years ago.

NAVAL LEADERSHIP AND THE AMERICAN BLUEJACKET. By Comdr. A. A. Ageton, U.S.N. New York: Whittlesey House. 91 pp. $1.25.

THE principles of leadership and their application to the problems aboard ship are impressed upon the young naval officer by means of anecdote and precept. The author knows his Navy, and advice and doctrine that apply there apply equally well to the Army. This is a valuable book to be used by all officers both as a personal help and to form the basis of instruction material to be used in training others.

STICK AND RUDDER. By Wolfgang Langewiesche. New York: Whittlesey House. 389 pp. $3.75.

THE author's name is not new to air-minded people as he has written several books on the subject of airplanes and their use and has been an instructor in theory of flight at the Hawthorne School of Aëronautics. This book follows four years of research, flying, and writing on the subject. He has the faculty of determining those intangibles that make flying differ from any other occupation, and he has been able to describe them in understandable language.

The book may seem too wordy for the casual reader, but for the student, for whom it was written and who is seeking a fuller knowledge of the subject, it is complete and informative. The author does not assume knowledge on the part of the student that is not there, and it is regrettable that more textbooks do not follow his pattern for the art of learning would thus be immeasurably advanced.

Flying is difficult—and more difficult to learn. Experience is the best teacher, but when it is coupled with good instruction the training of the pilot is speeded up. One commentator believes that study of this book is the equivalent of 400 hours in the air. The

Book Reviews

behavior of an airplane, which invariably is contrary to what is expected, actually follows basic physical laws if the pilot will but understand and recognize them. With a sound knowledge of these fundamentals and a mental picture of the three or four essential controls and reactions that enter into each movement of the plane, the pilot will never find himself in a desperate situation.

Leighton Collins contributes a chapter on "Dangers of the Air" and impresses the reader with the figures on air accidents. Contrary to public opinion, motor failure accounts for only six per cent, weather for eight per cent, and structural failures for eight per cent of the accidents. However, seventy per cent are due to going into a spin out of a turn, where the usual non-instrument flier suddenly finds himself, due to conditions, called upon to fly by instrument. Due to instrument lag and lack of training in recovery procedure, the pilot may fail to come out successfully, and a crash often results. This knowledge should aid in training future pilots.

THE SHIPS AND AIRCRAFT OF THE U. S. FLEET. By James C. Fahey. New York: Ships and Aircraft. 80 pp. $1.

THIS is a splendid reference work on the ships and aircraft of the U. S. fleet prepared by an associate of the United States Naval Institute. Issued in wartime, this edition is necessarily incomplete, as only a fraction of the United States Navy's tremendous expansion can be detailed.

Standard naval nomenclature is used throughout these pages. In addition to their type symbols and photographs, each vessel and all aircraft on the Navy list have distinctive serial numbers. Numbers assigned since late 1941 are classed as restricted information. Few have been released. Many older vessels have been reclassified. Some designations and numbers given in this volume no longer apply. Throughout the body of the booklet, war losses are indicated by crosses including those announced in Navy Communiqué No. 515, dated March 31, 1944. This booklet is of inestimable value for reference purposes as to all essential data regarding the U. S. fleet.

TWENTIETH CENTURY ENGINEERING. By C. H. S. Tupholme. New York: Philosophical Library. 201 pp.

THE author, within the limits of wartime security, has covered the latest advances in engineering, mainly those in Great Britain. Chemical and metallurgical research and use are particularly well covered. This book is not a textbook, but it is sufficiently informative to give the reader a clear idea of the subjects described. It is an interesting refresher on general engineering advances.

DICTIONARY OF ORDNANCE TERMS. By H. Strom. New York: Frederick Ungar Publishing Company. 440 pp. $5.

THIS volume of 440 pages is a glossary of terms connected with arms, ammunition, explosives, and other armament material in five languages: English, French, German, Italian, and Spanish. It was prepared by Mr. Strom in collaboration with A. F. Stoeger, Jr., Jules Michaux, U. W. Baldi, and W. Boehm.

BOOKS RECEIVED

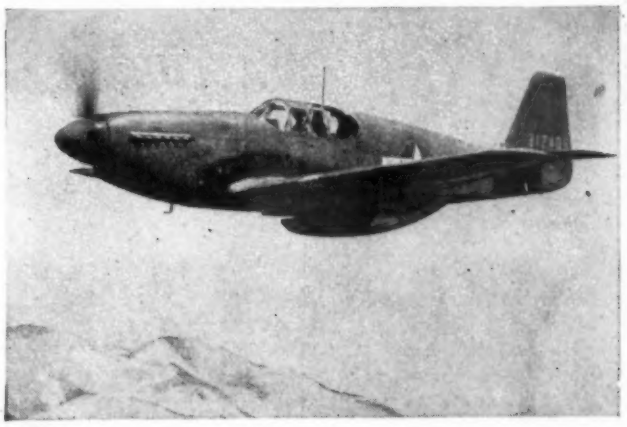
THE MAKING OF MODERN CHINA. By Owen and Eleanor Lattimore. Washington: *Infantry Journal*. 178 pp. $0.25.

SOLDIERS IN THE PHILIPPINES. By William Thaddeus Sexton. Washington: *Infantry Journal*. 246 pp. $0.25.

WIND IN THE SAHARA. By R. V. C. Bodley. New York: Coward-McCann, Inc. 224 pp. $3.

PICTORIAL GUIDE TO MACHINE SHOP PRACTICE. By H. Grisbrook and C. Phillipson. New York: Emerson Books, Inc. 91 pp. $1.50.

PRACTICAL MALARIA CONTROL. By Carl E. M. Gunther. New York: The Philosophical Library, Inc. 91 pp. $2.50.



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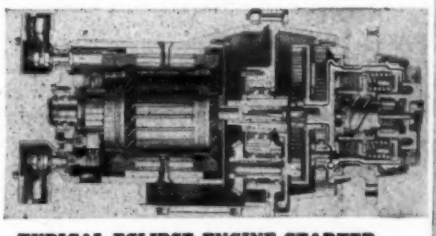

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